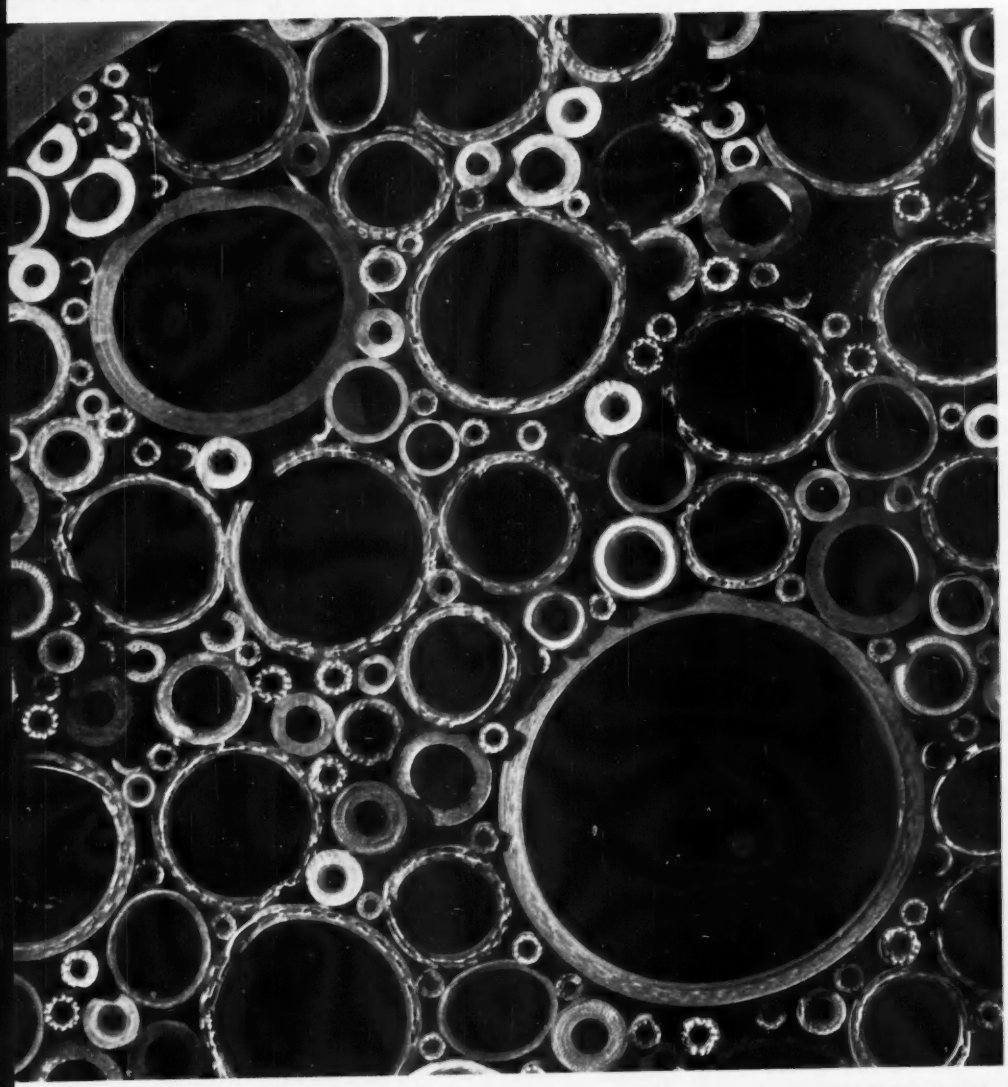
Compressed Air Magazine



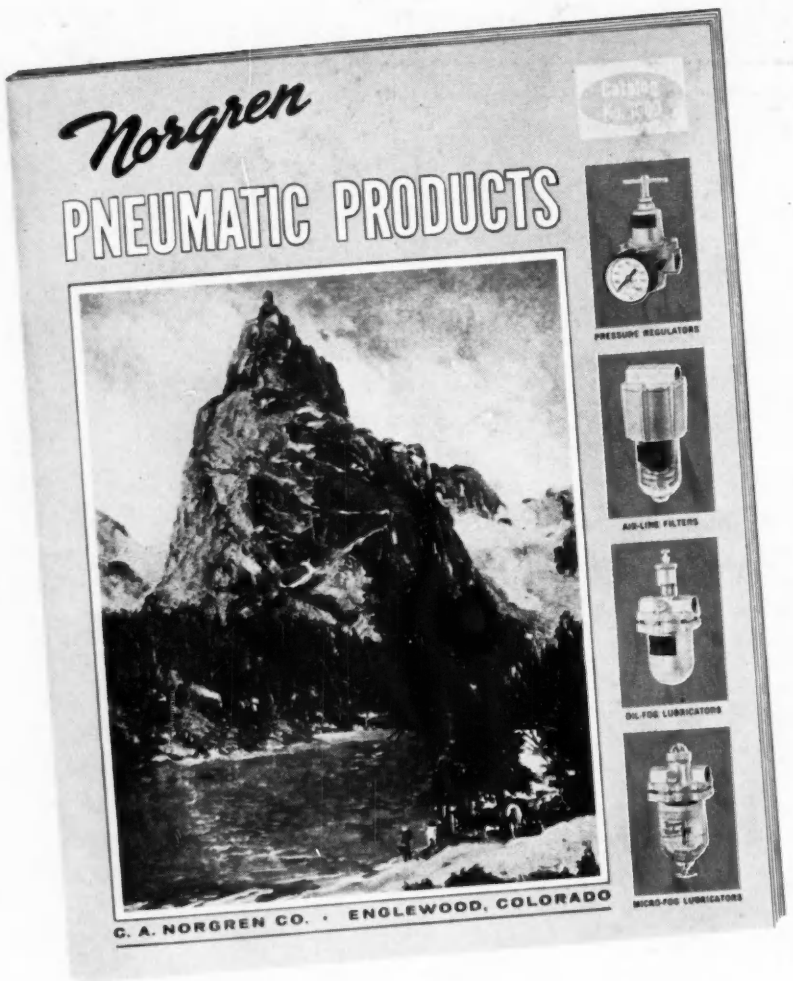
JULY 1961

IN THIS ISSUE:
OMAHA'S PEAK-SHAVING PLANT
POOL HEATERS AND AIR TOOLS
BALLOON-BORNE TELESCOPE
A FILTER MAKER'S HISTORY

If you use or design for compressed air

...and don't have this new catalog...

be sure to send for it *today!*



Please fill out this coupon or write on your company letterhead

FOUNDED IN 1926

C.A.NORGREN CO.

3407 SOUTH ELATI STREET
ENGLEWOOD, COLORADO

To: C. A. NORGREN Co., 3407 So. Elati St., Englewood, Colo.

Gentlemen: Please send me without cost or obligation your new catalog, No. 1000, on the complete Norgren line of pneumatic products.

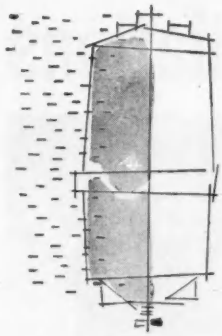
Name_____
(Please print)

Title_____

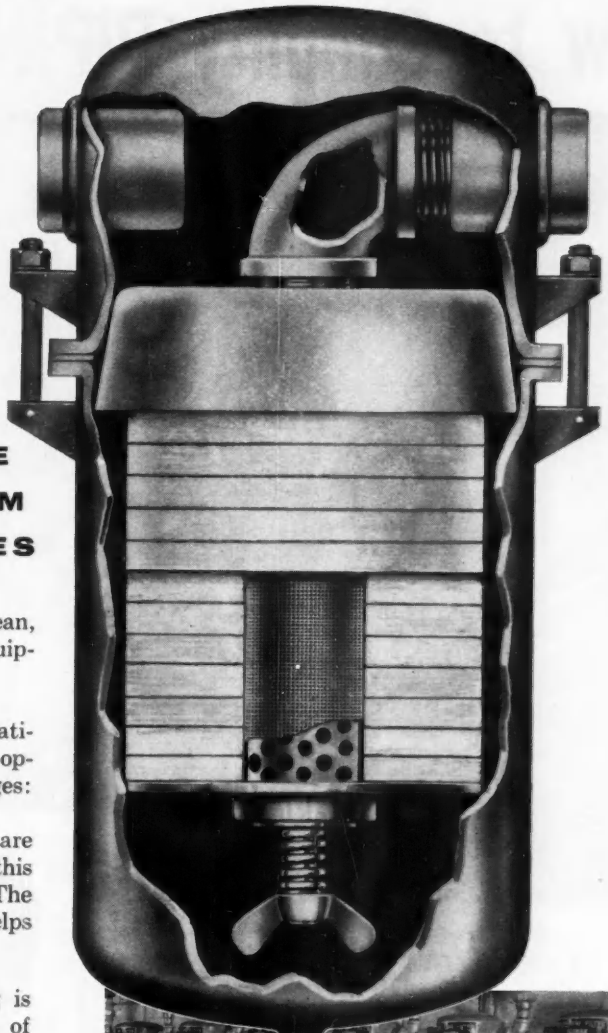
Company Name_____

Company Address_____

9611



DOLLINGER
DRY FILTER
SPECIALISTS
FOR
40 YEARS



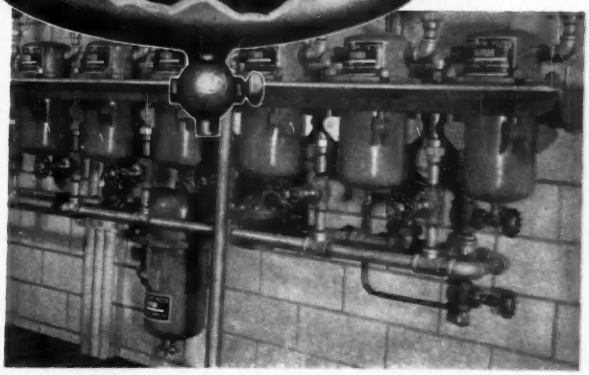
REMOVE MOISTURE AND DIRT FROM COMPRESSED AIR LINES

Dollinger Staynew Filters keep air dry and clean, assure smooth operation of mechanical equipment despite constant change in humidity.

Model AAPHS Staynew Filters protect pneumatically-operated controls, instruments and air-operated tools. They offer a variety of advantages:

- Low resistance—heavier dirt particles are eliminated before the air itself is filtered; this prevents clogging of the filtering element. The result is low resistance to flow; this helps maintain line pressures, saves horsepower.
- Continuous operation—frequent cleaning is eliminated because of a liberal amount of space in the housing for accumulated dirt and condensate; this can be drained without shutting down the line.
- Accessibility—interior parts are easily exposed for inspection and cleaning. Loosening of swing bolts permits removal of lower housing without breaking pipe connection.

For positive, trouble-free filtration, specify Dollinger. Call our representative nearest you, or write for Bulletin 200. Dollinger Corporation, Industrial Products Division, 7 Centre Park, Rochester 3, New York.



Part of an installation of 18 Staynew Filters protecting air-operated instruments in a power plant. Model AAPHS Filters operate effectively at pressures as high as 125 lbs. gauge.

PROTECTOMOTOR
STAYNEW
FILTERS

DOLLINGER

LIQUID FILTERS • PIPE LINE FILTERS • INTAKE FILTERS • HYDRAULIC FILTERS • ELECTROSTATIC FILTERS • MIST COLLECTORS • DRY PANEL FILTERS • SPECIAL DESIGN FILTERS • VISCOUS PANEL FILTERS • LOW PRESSURE FILTERS • HIGH PRESSURE FILTERS AUTOMATIC VENTILATION FILTERS • NATURAL GAS FILTERS • SILENCER FILTERS

How to Simplify PIPING Installations

NAYLOR Wedgelock couplings make a positive connection securely anchored in standard weight grooved ends.

If your job calls for air, water or ventilating lines, you'll be time and money ahead to use NAYLOR Spiralweld pipe and NAYLOR Wedgelock couplings.

This combination simplifies pipe line construction. The pipe is easier to handle, easier to install. Although it is light in weight, there's no sacrifice of strength due to the exclusive lockseamed-spiral-welded structure which creates a stronger, safer pipe.

The Wedgelock coupling saves time and work, too, because it speeds connections. A hammer is the only tool required to connect or disconnect it and lines can be made up with only one side of the pipe in the open.

For details on this time-and-money-saving combination, write for Bulletin No. 59

NAYLOR PIPE *Company*

1245 East 92nd Street, Chicago 19, Illinois

Eastern U. S. and Foreign Sales Office: 60 East 42nd Street, New York 17, N. Y.

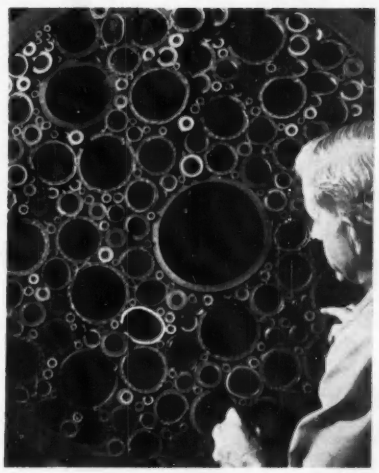
Volume 66 Number 7

July 1961

Compressed Air MAGAZINE

BPA

Editorial, advertising and publication offices: 942 Memorial Parkway, Phillipsburg, New Jersey. Annual subscription, United States and possessions, $5; foreign, $7; single copies, domestic $0.50, foreign, $0.70. Compressed Air Magazine is indexed in Industrial Arts Index and in Engineering Index. Microfilm volumes (1940 to date) are available from University Microfilms, Inc. Published monthly by Compressed Air Magazine Company: A. W. Loomis, President; L. C. Hopton, Vice President; C. H. Biers, Secretary-Treasurer.



on the cover

It's not a photomicrograph from a botany class, though the tubes shown function not unlike a plant's circulatory system. To make the picture, Goodyear people slipped some 350 different samples of hose into a huge dredging sleeve. A portion of the sleeve, the largest variety of hose made, is visible at the upper two corners. Hose of course is used by many types of industry and mining; and according to Goodyear engineers, no other rubber product has as many applications or requires as many types of rubber. The cover picture is cropped; the complete photo here indicates the scale.

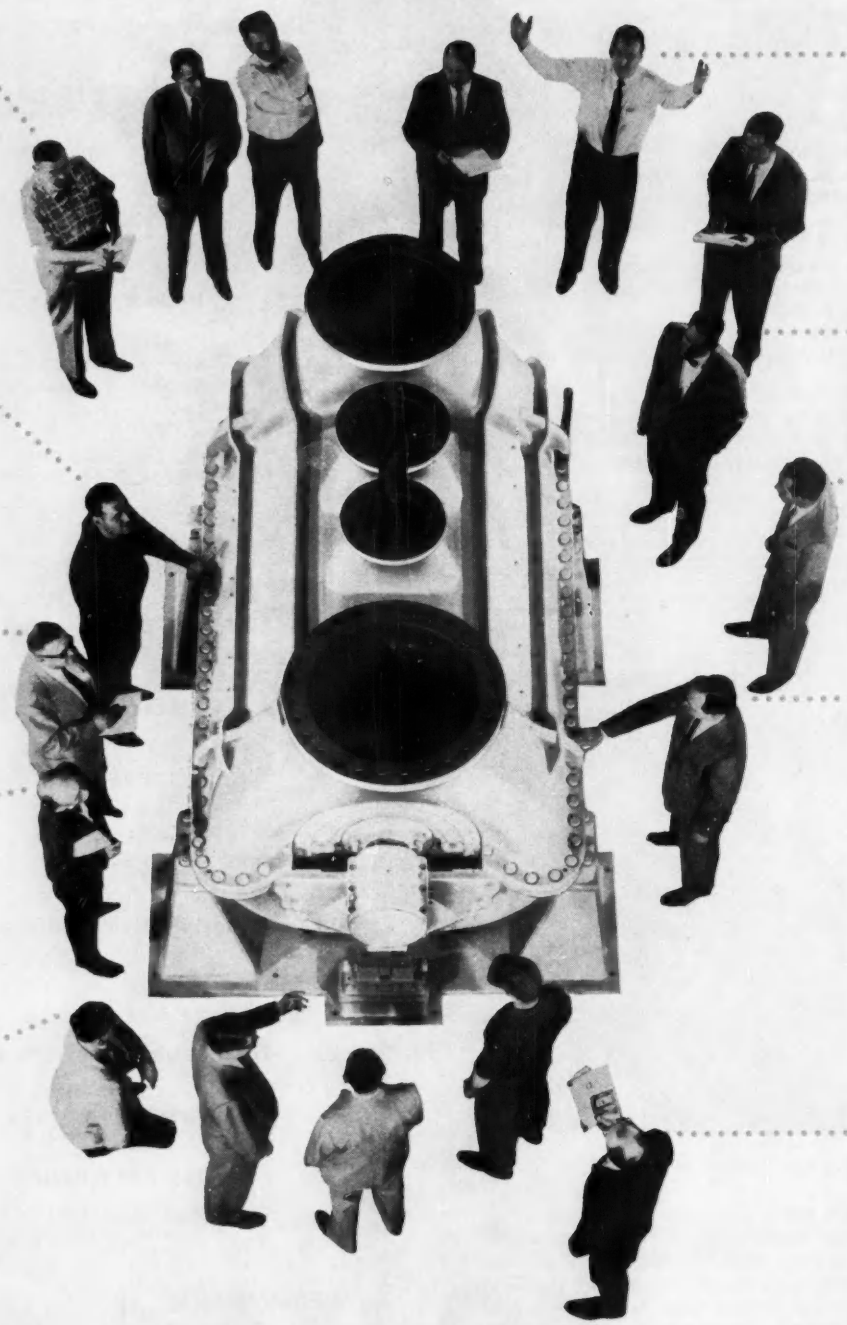
It's the first of its kind ever built in America

It saves up to 25% on horsepower

And 70 to 90% of its power is recovered as hot air for drying

It has reserve capacity, too— no more vacuum pumps to add

Horsepower used is proportional to the actual vacuum capacity you need



Only one unit for an entire paper machine!

The design has been thoroughly proved. You can't beat it for reliability

And it doesn't need any seal water

All the white water is recovered and can be re-used

Automatic control provides vacuum and capacity as required

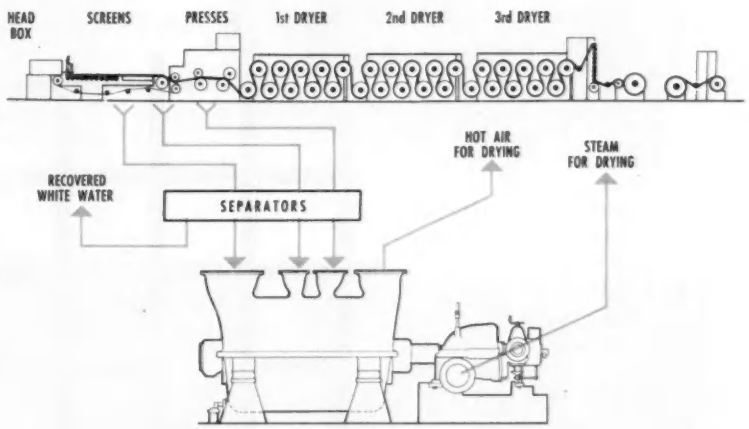
Ingersoll-Rand opens a NEW ERA for the paper industry

...with the FIRST Central Vacuum System for an American Paper Mill

America's first central vacuum system for paper machines is now a reality. This Ingersoll-Rand centrifugal exhauster, with associated separators and controls, constitutes a complete system that meets *all* the vacuum requirements for an entire paper machine. What's more, it also provides an abundant supply of hot air for drying, saving thousands of dollars a year in drying costs.

This first unit, shipped in May, provides a total capacity of more than 36,500 cfm at vacuums of 10″, 15″ and 20″ Hg. Requiring 1,065 bhp, it will do the work that would require 6 individual wet vacuum pumps totaling 1,285 hp, with plenty of reserve capacity to handle extra loads for higher paper machine speeds and changing basis weights. Net saving, 220 hp! Two additional I-R vacuum systems are now being built for two other paper mills.

Ingersoll-Rand can design and build central vacuum systems to meet the exact vacuum and hot-air requirements for any type of paper machine. Ask your I-R engineer for complete information, or write to Ingersoll-Rand, 11 Broadway, New York 4, N. Y.



The I-R Central Vacuum System is an INTEGRAL PART of the paper making process.

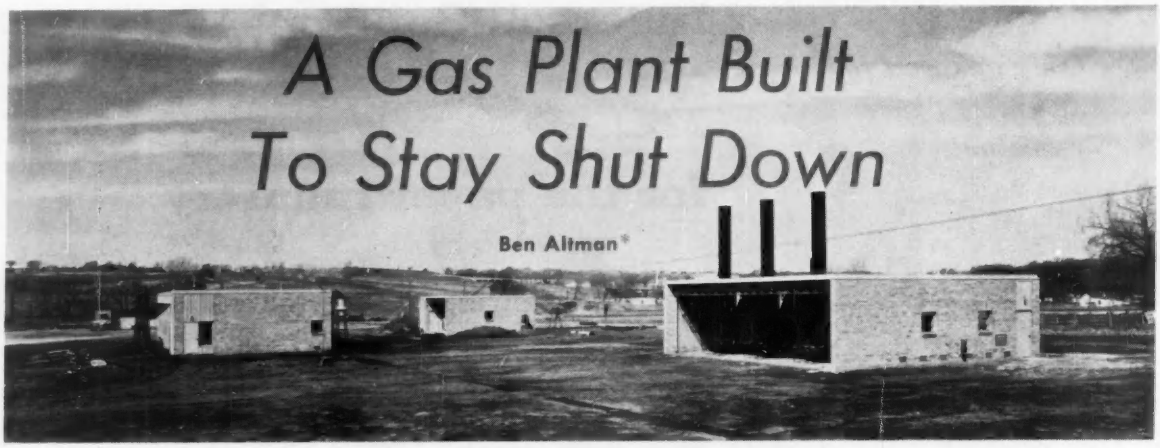
Ingersoll-Rand
11 Broadway, New York 4, N.Y.

THE WORLD'S MOST COMPREHENSIVE VACUUM EQUIPMENT EXPERIENCE

271 A 12

A Gas Plant Built To Stay Shut Down

Ben Altman*



FROM LEFT, THE PLANT INCLUDES COMPRESSOR, MIXING AND VAPORIZER BUILDINGS. STORAGE CAVERN IS 1/4 MILE AWAY.

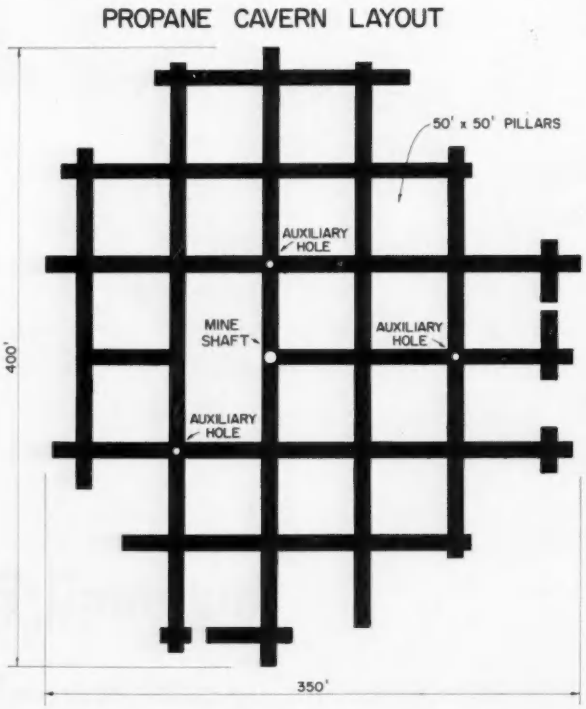
ANY manufacturing man knows that a well-managed plant is one operating at its maximum. Idle equipment and unused space spell inefficiency and loss in potential profit.

To construct a $1,500,000 manufacturing plant, then, with the intent of running it only 5 or 10 days a year would seem downright foolhardy. To hope that the plant would never be operated would seem bizarre. The Metropolitan Utilities District, Omaha, Neb., completed just such a plant early this year and is, at the moment, considering erecting a second installation that will cost $2,000,000.

The District is one of the thousands of natural gas distribution utilities throughout the U.S. that have built or are building new manufacturing facilities to supply part of their gas needs. They have found this to be the most economical method of meeting peak loads, even though the plants operate only a few days each year.

The economics run this way. Under current federal regulation, most gas transmission companies are required to charge a 2-part rate. The first part usually consists of a demand charge. It is figured on the highest single day's volume that the distributor expects during the year. In other words, the utility company pays for the guarantee of delivery of a certain maximum gas volume, should it be needed. The second charge is assessed on the unit volume actually delivered. The way to save money (visualizing a year's consumption plotted as a curve) is to "shave" off the few days of high volume by contracting for only the gas that will handily meet average needs. Any extra fuel required can be supplied by the gas manufacturing plant the utility has built. Such facilities are called peak-shaving plants.

Because of the low cost per unit of production, propane-air plants, such as the District's, are one of the most economical means of providing capacity for these peak loads. The District currently pays $46,000 per year for each million cubic feet of daily contract capacity. The new gas plant, with a capacity of 30,000,000 cubic feet per day, will permit reduction of the daily capacity contracted for by an equal amount. The resultant reduction in annual demand charge comes to $1,386,000, or, in a single year, enough savings to equal nearly the total cost of the new plant.



Although the cost of the propane-air fuel itself is low, until recently its use was limited because storage equipment was expensive. With the development of cavern storage, however, it is now possible to keep large quantities in reserve at a comparatively low cost. Storage for more than 4,000,000 gal-

* Mr. Altman is rate and research engineer for the Metropolitan Utilities District.

Cavern Construction

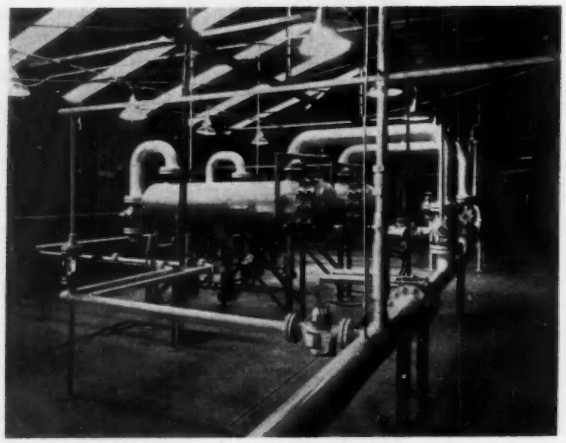
42-inch casing is placed in 300-foot initial shaft

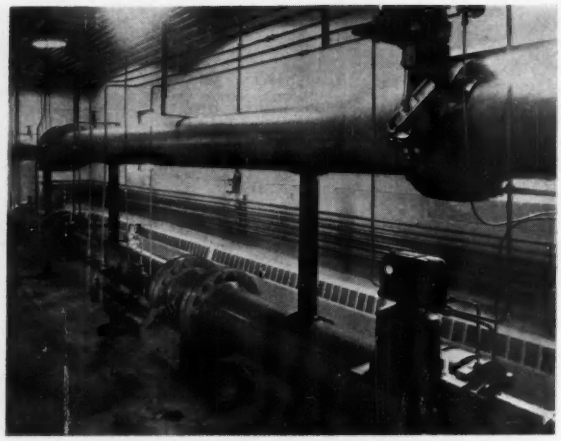
Buckets like this are the only mode of entry

Blast holes are drilled
with an Ingersoll-Rand Drifter

As the cavern expands, Eimco overshot
loaders are put to work

The chamber widens still more; D-6 tractors eventually handle the muck





FILTERS, VALVES The filter separators immediately above are located in a building at the cavern. They remove free water and solids that the propane picks up. In the right photo are the propane and air lines in the mixing building a quarter of a mile from the cavern. Proportioning butterfly valves are at left and air-operated shutoff valves at right.

lons can be constructed for as little as 20 percent of the cost of surface facilities. As a result, propane-air plants can now be used to supply a larger percentage of the peak load needs.

The District's plant consists of the underground storage area, liquid pumps to withdraw the propane from storage, vaporizers to convert the liquid to vapor, a sufficient supply of air to dilute the vapor to the proper heating value and mixing facilities to insure a homogeneous product. The plant has been semi-automated with each of these phases operating automatically, once production is started.

Construction of the plant began in September 1959 with the drilling of the main shaft for the storage cavern. Borings on the 40-acre site adjacent to the District's Construction & Materials Storage Center in the northwest section of Omaha had indicated a suitable formation for a mined propane storage cavern at a depth of approximately 300 feet. A limestone formation several feet deep was to serve as the roof while the shale formation immediately below would provide an impermeable structure that could be mined at comparatively low cost.

Drilling of the main shaft was completed in December 1959 with the placing of the 42-inch steel casing through which the mining was subsequently carried out. The contractor, Fenix & Scisson, Inc., Tulsa, Okla., then began driving a network of tunnels approximately 10 feet wide and 25 feet high to contain 7,500,000 gallons of liquid propane. (A similar mining operation, also a Fenix & Scisson job, was described in detail in "Catacombs For Gas," *Compressed Air Magazine,* November 1959.)

Because of the limited area at the bottom of the shaft the mining at first progressed slowly with the work being done with air-operated hand tools. As soon as the drifts had been extended to provide sufficient area, two Eimco air-operated muckers were lowered piece by piece down the shaft and reassembled. These units loaded spoil into the mine buckets to be brought to the surface.

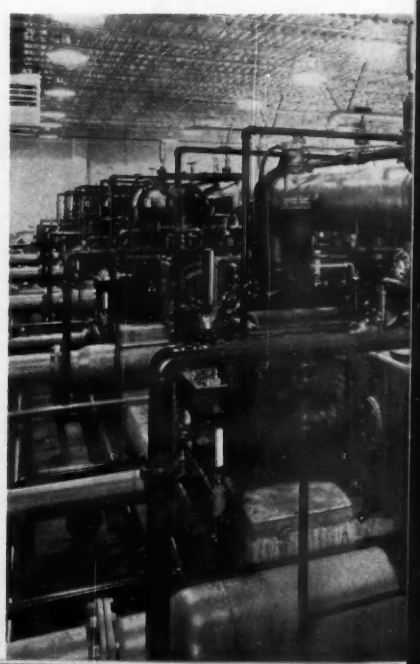
As the drifts extended farther from the shaft, two D-6 tractors with front end loaders were lowered piece by piece to the mined area. After reassembly they were used to haul the spoil from the face of the drift to the shaft for loading by the muckers.

The mining of the cavern was completed in June 1960. The 42-inch steel cap was welded to the shaft, the pumps for withdrawal of the propane installed and fill lines extended to the railroad unloading siding. After pressure testing, followed by purging with flue gas, initial filling began. The first 250,000 gallons was injected into storage as a vapor to bring the cavern to its operating pressure of 115 psig. Injection of liquid into the cavern before this pressure was reached would have allowed the liquid to flash to a vapor. The accompanying refrigeration effect would have caused contraction of the steel casing with possible breakage of the surrounding cement seal.

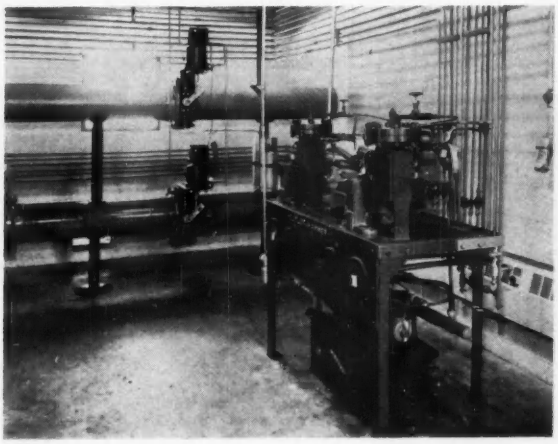
The remainder of the plant facilities were completed in December 1960, and the plant went into operation in January.

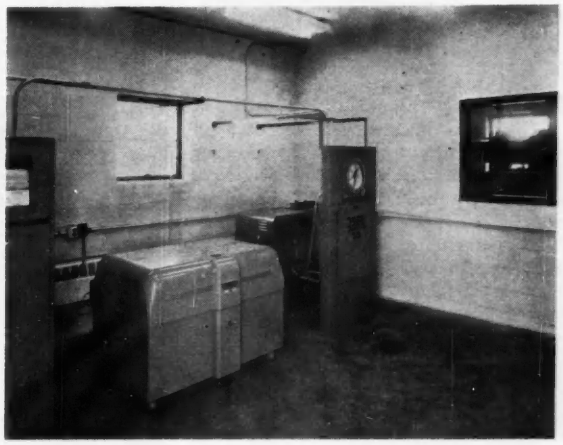
Using either of the deepwell turbine pumps installed in the cavern, the propane is withdrawn from storage at rates up to 300 gpm. The propane is passed through a filter separator which removes all solids 40 microns or larger. These units also cause any free water in the propane to coalesce and drop out through the trap.

The liquid propane then flows to three indirect fired vaporizers each with a capacity to vaporize 100 gpm at 125 psig and superheat the vapor to 140° F. The two burners on each vaporizer can supply a total heat input of 7,000,000 Btu/hr at full load. The vaporizers are similar to Scotch marine boilers. A shell 5 feet in diameter and 28 feet long contains water, the heat transfer medium,



COMPRESSORS In the foreground is one of five Ingersoll-Rand HHE compressors that supply air to the peak-shaving plant. Each of the 4-cylinder, 371-hp units delivers 1650 cfm at 125 psig. They are driven by Climax 12-cylinder gas engines; an engine is visible at far right here.



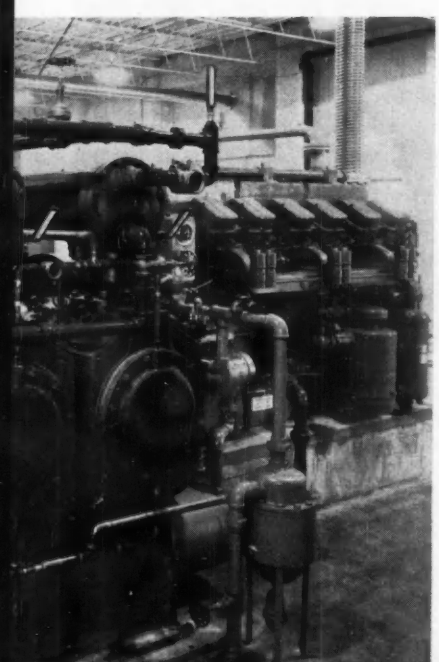


CONTROLS Propane and air are kept in correct ratio by the Cutler-Hammer automatic proportioning controls, above. In the background are the same shutoff valves illustrated on the opposite page. The right picture here shows a calorimixer and calorimeter setup that tests and adjusts the heating value of the mixed gas. Both of these control systems are in the mixing building.

which is automatically maintained at 180° F.

To guard against leaking vapor reaching the burners, they are mounted outside the building through a vapor-tight wall. The propane coils enter the opposite end of the vaporizer inside the building. In addition to the automatic burner controls to maintain the water temperature at 180° F, each unit is equipped with air-operated safety controls to shut off the flow of propane in the event of low water temperature or low vapor discharge temperature.

The air for mixing is supplied by five 2-stage, 371-hp Ingersoll-Rand HHE compressors of 5-inch stroke. Each 4-cylinder unit delivers 1650 cfm at 125 psig when operating at 1000 rpm. Because the air flow is used for the primary flow control, the production rate can be varied from 20 to 100 percent of capacity in five steps by varying the number of compressors on line.



Although the compressors are designed for continuous full load operation, controls are included for unloading all cylinders through the intake valves. This permits the compressors to remain on line in the event a plant safety shutdown control is tripped. A malfunction in one of the production phases can normally be corrected or bypassed immediately and operation resumed without having to restart the compressor drives. Relieving of the air to atmosphere would not be satisfactory because a residential area is located only a few hundred feet away.

Each compressor is powered through direct drive by a Climax V-125 12-cylinder natural gas engine. The engines are equipped with Ingersoll-Rand 20BM air starting motors. Starting air is provided by two Type 30, Model 234 compressors, which also supply air for the vaporizer controls and pneumatically operated valves that are housed in the mixing station.

The engines and compressors have separate closed cooling water systems with shell and tube-type heat exchangers. Water from the District's distribution system is used for cooling in the heat exchangers and intercoolers. Since the plant is operated only during the winter it is possible to take advantage of the excess water distribution capacity available at that time, thus eliminating the investment and maintenance expense of cooling towers. The water temperature during the winter is fairly constant at about 40° F.

No aftercooling of the compressed air is necessary. The heat from the second stage of compression together with the superheat of the propane vapor helps to warm the cold natural gas which drops to as low as 10–0° F. This additional heat insures against condensation of the propane vapor and the moisture present in the compressed air.

The engines and compressors are equipped with controls for shutdown in the event of high cooling water temperatures, low oil pressure, and high intercooler air temperature. The units are housed in a permanent masonry building and the engines equipped with residential-type exhaust silencers so that they cannot be heard in the adjacent homes.

The air makes up approximately 50 percent of the final propane air mixture, thus diluting the heating value of the propane vapor from approximately 2600 Btu to 1300 Btu/cu. ft. Since the propane-air is almost twice as heavy as the 1000 Btu of natural gas, this higher heating value is required to maintain the same burning characteristics. The propane-air then discharges into one of the 100 psig distribution mains and is mixed again with an equal or greater volume of natural gas. The resultant mixture can be burned satisfactorily on appliances adjusted for straight natural gas.

The propane and air flow through separate 12-inch lines to the automatic mixing station. The gas is first mixed volumetrically to the approximate heating value. Through a series of hydraulically operated butterfly valves activated by differential pressures regulators, the flow of air is metered and the flow of propane vapor proportioned to produce the desired mixture. Beyond the mixing station the propane and air streams are brought together in a short section of large diameter pipe with a

About the Metropolitan Utilities District

THE Metropolitan Utilities District of Omaha is an agency of the State of Nebraska. It was created in 1912 by an act of the State Legislature originally to operate the Omaha Water Company which had been purchased by that city. The operation of the water system was so successful that in 1920 the city purchased the facilities of the Omaha Gas Company. Since that time, the District, under the direction of six board members elected by citizens in the service area, has provided both water and gas to Omaha and the surrounding metropolitan area.

Prior to 1947 the District supplied manufactured gas to some 60,000 customers. At that time the gas was used primarily for cooking and water heating and the average daily sales was approximately 12,000,000 cubic feet. On a cold morning use of gas ovens to warm kitchens would occasionally produce a peak day of 17,000,000 cubic feet.

The conversion to natural gas in 1947 resulted in thousands of customers converting to the lower cost fuel for heating homes and buildings. The district now supplies gas to over 90,000 customers, and 69,000 of them use the fuel for heating. With this tremendous rise in consumption, the weather has become the determining factor in the daily sales volume. Sales now vary from a low of 15,000,000 cubic feet in the summer to 160,000,000 cubic feet on the coldest winter day.

Omaha normally experiences 5 to 10 days each year when the mean temperature is from 0 to −15° F. The District must be prepared to meet these peaks with its contracted natural gas and with fuel from its propane-air plant. It is of course more than a matter of cost, which the accompanying article primarily stresses. An insufficient supply of gas for heating when the temperature is hovering below zero would be a severe blow to a gas distributor's reputation and would mar the whole industry's tradition of continuity of service.

CAVERN SITE A District engineer, Martin Lesser, and a drill-rig operator inspect cores taken before the cavern was excavated. The District is planning a second peak-shaving plant, a $2,000,000 project that will also make use of a mined reservoir.

---

series of baffles welded to the interior to insure thorough mixing.

A sample of the mixed gas is returned to the control room of the station where the heating value is automatically determined by burning in a calorimixer and calorimeter. In the event the value varies from the standard, these instruments send an impulse to a motor driven linkage on the propane differential regulator causing the propane flow to increase or decrease accordingly.

Too low a pressure in the propane or air line, or a malfunction of the mixing equipment, will activate a pilot in the control air line automatically closing the pneumatic safety shutoff valves in both the propane and air lines. The difficulty must be corrected and the pilot manually reset before operation can be resumed.

Each morning the District's dispatcher consults the weather forecast and from this estimates volume of gas required for the day. If the 112,000,000 cubic feet of natural gas which the District presently contracts for is insufficient to meet the day's requirements, the gas production superintendent is advised of the volume of manufactured gas which will be required. The dispatcher checks the actual temperature each hour and the supplementary weather forecasts received every 6 hours. From these, revised estimates are continually made. The gas production superintendent adjusts the production rate accordingly.

Two operators are required to place the plant in operation. The liquid pumps and air compressors are started manually and the necessary valves opened to pressurize the lines to the mixing station. The mixing controls are set for the desired heating value. The 16-inch pneumatically operated valve on the discharge from the mixing station is then opened and the operation continues automatically until this valve is closed to shut down the operation.

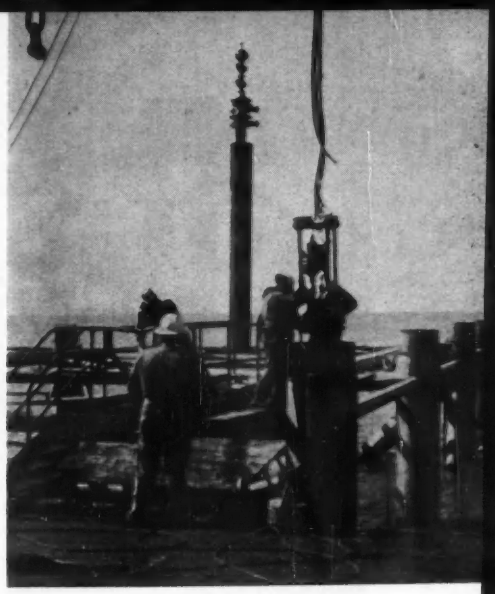
Because of the mild weather since January, sufficient natural gas was available to meet all requirements. Test runs were made on five occasions with a total operating time of 12 hours at varying capacities. The operation of all equipment was satisfactory. After 10 to 15 minutes warm-up time for the engines and compressors, the plant can be put in operation in less than 2 minutes.

Even though it was not necessary to produce gas due to the mild winter, the fact this production capacity was available permitted the District to reduce its contract volume by 30,000,000 cubic feet per day with a corresponding reduction in the annual demand charge. In short, the unique but ideal situation of letting the brand new $1,500,000 installation lie idle was achieved.

A second plant now being designed will have production facilities and a mined cavern for the storage of 8,400,000 gallons of liquid propane. Completion of this $2,000,000 plant, scheduled for 1963, will bring the total production capacity to approximately 32 percent of the peak days' requirements.

Diver and Torch Yield to—

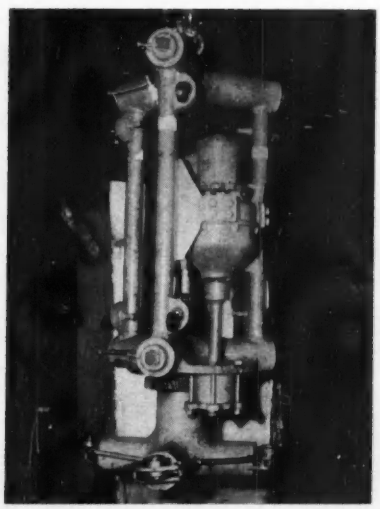
Air-Powered Pipe Cutter



LOWERING FOR WORK After dropping down this 30-inch pipe to a depth of 90 feet, the unit can complete a cut in 22 minutes. The air motor that powers the cutter is remote-controlled from surface positions.

THE FEDERAL government requires casings and off-shore structures to be removed when a well is abandoned because they are hazards to navigation. Furthermore, oil companies have a considerable investment in steel pipe and wish to reclaim as much as possible. For example, 30-inch pipe has a salvage value of about $50 a foot. Yet, underwater cutting of well casings and pilings has always been a difficult and expensive problem.

Common methods used to recover the steel are the cutting torch and the dynamite blast. In the case of the former, divers must go down to handle the torch. As for blasting, it is hazardous and can cause considerable damage to salvageable structures. Use of a cutting torch under water is also considered hazardous and is both slow and expensive. As oil exploration moves into deeper and deeper water, the length of time a diver can stay down is progressively diminished.



READY FOR USE The Wireline cutter before operations at a Shell off-shore installation. The cutting head with its four Simonds molybdenum circular blades is driven at 4.65 rpm by a Size 55R Ingersoll-Rand air motor. Air pressure at 600 psig forces pistons out to hold the unit in position and to push blades against the pipe.

Wireline air-powered pipe cutters promise to replace the diver and his torch in such off-shore operations. Results will undoubtedly be a sharp reduction in time and costs, improvement in salvage value, and elimination of job hazards. The cutter is built by Wireline Pipe Cutter Company, New Orleans, La. At present the company sells its services, utilizing its own cutters in its contract work.

Consider a completed job. The Wireline unit cut off a 30-inch casing at 90-foot depth at a Shell off-shore installation in the Gulf of Mexico. Time: 22 minutes. If a large number of pipes were to be cut, two units would have been used so one could be cleaned, adjusted and put into position while the other was cutting. Operating this way, in 100 feet of water, Wireline president J. Hartley says a pair of cutters would average two pipes an hour—sixteen every 8-hour day. In this particular case, the Shell foreman reported the remote-controlled cutter was simple to operate, completely eliminated underwater hazards, and provided a smooth, clean cut flush with the bottom. This yielded maximum salvage value.

Here's how the cutter works. The unit, which is compact, is lowered into the pipe. It makes its slice from the inside. When lowered to the desired depth, 600-psig pressure air is admitted to two sets of supported arms radiating from a vertical tubular support shaft. The air forces the arm pistons out against the pipe, holding the cutter firmly with its central shaft parallel with the pipe axis. At the bottom of the central shaft, four cylinders extend radially, each with a piston fitted with a Simonds molybdenum circular cutting blade. When the cutter is positioned firmly in the pipe, compressed air is admitted to the four cylinders of the cutting head, pushing the blade-tipped pistons against the pipe. Initial air pressure is throttled down to 25 psig, and is built up to 600 psig as cutting proceeds.

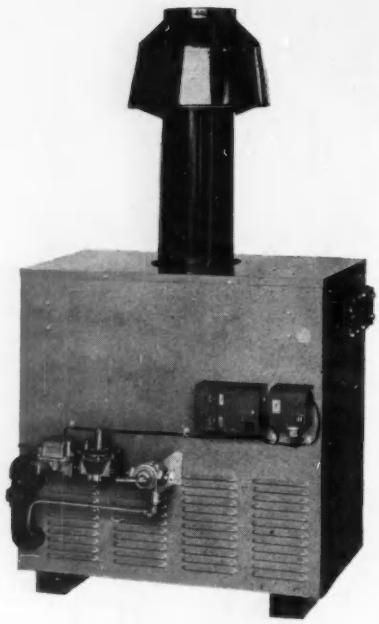
The cutting head is rotated at 4.65 rpm by an Ingersoll-Rand air motor built into the unit and driven by 125-psig pressure air. The Size 55R motor is a rugged tool originally designed for rolling heavy tube in steel mills and with 100-psig pressure air exerts a torque of 2460 foot-pounds. In the Wireline cutter, the motor operates the cutting head through a set of reduction gears. The operator on the surface regulates the motor with a remote-control throttle.

On the Shell job, air was supplied to the cutter through 450 feet of $1^1/_4$-inch hose. The 600-psig air was provided by a diesel-driven Ingersoll-Rand compressor. A second I-R compressor, rated at 300 psig, supplied the 125-psig air for the motor. This was adequate for the job.

The cutter, complete with its air motor, operates smoothly under water without slowing down even though temperatures are quite low. When a cut is completed, all pressure is released. Springs retract the support and cutting head pistons so the unit can be easily removed from the pipe. At the surface, the air motor is run in reverse, oil being put through to clean it.

The cutter used on the Shell job can sever any pipe with an inside diameter varying from 24 to 36 inches. However, the Wireline unit comes in other sizes to handle pipe from 12 to 72 inches. All units are skid-mounted.

It should be pointed out that in addition to its role in removing casing and structures, the cutter's use in extensive repair of structures is also foreseen. Damaged sections can be cut away cleanly and then sleeves can be welded in place to effect the repair. Another advantage noted is the ease with which the cutter can be positioned in off-set wells: it is self-aligning. On land, the unit may make it possible to salvage more casing from abandoned wells.



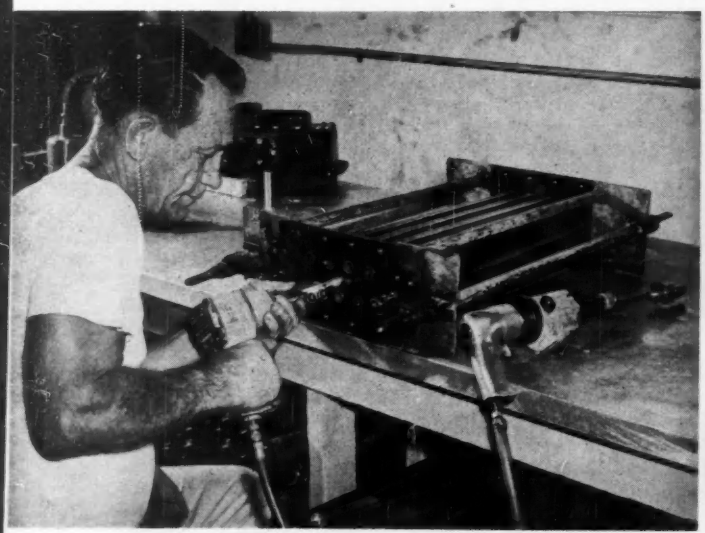
HEATER The South Seas heater presents an attractive appearance to the potential buyer. The thermostatic "brains" of the unit are mounted on the side. It was the use of these automatic controls in a competitively priced heater that let Fleetwood break into the market.

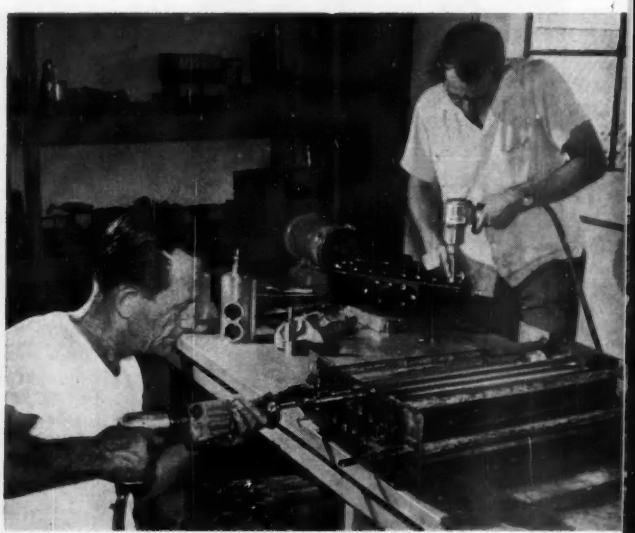
The Small Business

and Air Tools

Robert James

FORMING a small business could be called the great American pastime. Thousands are organized each year, capitalized with a few hundred to several thousand dollars. The smash of a lot of dreams is heralded by the failure rate,





HEATER ASSEMBLY In these four photos, five major pneumatic tool operations on the pool heater are shown. Directly above, an Ingersoll-Rand 804 Impactool is being used to trim heater tubes held in a jig with tube sheets in place. After trimming, the tubes are rolled (next picture) to seal them to the tube sheets. The tool is an I-R 1ATR designed for this service. In the background, an 804 Impactool is being used to assemble the water tank. In the picture at right, the tank is being assembled to the tube sheets, also with an 804 tool. In the picture at the far right, spuds are being run into the burner manifold, again with the versatile 5-pound 14-ounce 804 Impactool.

which last year rose to a 20-year-high of 57 per 10,000 businesses. A total of 15,445 firms were closed by bankruptcy, according to Dun & Bradstreet reports.

Management experts say that almost without exception the small businesses that do succeed—and some do fabulously—succeed because the basic principles of wise management (cost, production and inventory control, merchandising, etc.) were followed. A good product, of course, is required for success, but in itself is no guarantee.

High labor and material costs are no strangers to the small businessman. Indeed, his problems may be many times amplified because he does not have the high volume over which to spread his basic or overhead costs.

It is with some interest then that the small businessman follows developments in large industries aimed at controlling costs and assuring high productivity. His capital is limited, of course, and his volume of business does not permit the purchase of some of the larger items of automated equipment. He can, however, take advantage of such big-business-proven equipment as portable hand-held pneumatic tools. In comparison with other capital goods, these tools don't have high price tags. In addition, their advantages almost immediately will show up on the profit side of the ledger.

The superiority of power tools over manual tools has been well proved to thousands of businessmen ranging from garage owners to manufacturers. Richard Goehring is one small businessman that found almost as great a difference between air and electric tools. Three years ago, in South El Monte, Calif., Goehring founded Fleetwood Manufacturing Company, Inc., with an initial capitalization of $5000. In 1960 the firm grossed just under $1,000,000. Six production employees man the assembly line and turn out a swimming pool heater much in demand in Southern California. The firm is free of debt today with the exception of one loan secured by its new plant building.

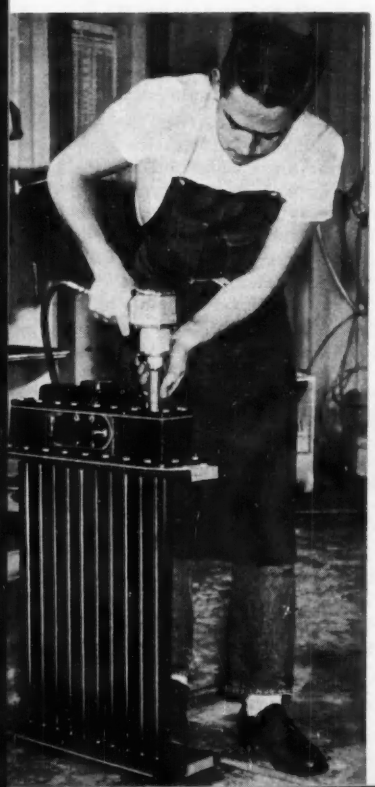
Goehring equipped his men with electric impact wrenches when the concern got under way. These were used not only for nut running, but were equipped for rolling finned heat-exchanger tubing into tube sheets. Maintenance costs and down time charges attributed to the tools were very high. Goehring investigated pneumatic tools and received a recommendation for heavy-duty industrial pneumatic Impactools as well as a pneumatic tool especially designed for tube rolling service. The air tools outlasted the electric tools by factors up to 3:1, upped production by 30 percent in the case of the tube roller, and paid for themselves within 30 days.

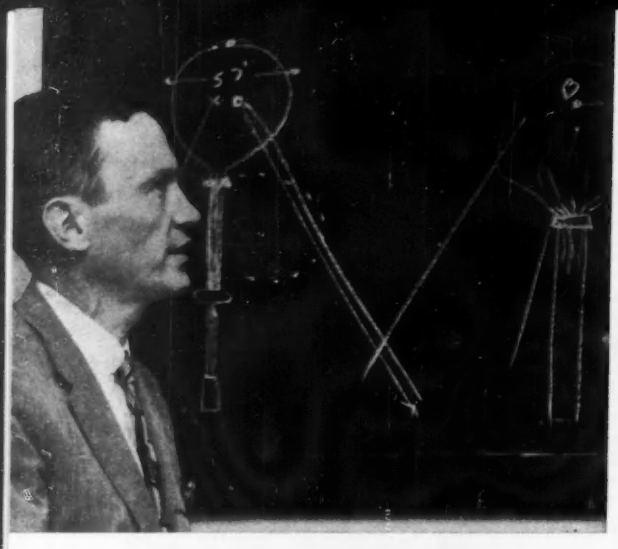
Goehring cites the oftheard advantages of lightweight, low maintenance, ability to take overloads including full stalls, and adaptability to a variety of tasks as the reasons for the tools' short amortization period. Infrequent maintenance is a big item to a business that does not have the necessary volume of work to stock spare tools; or even much in the way of spare parts.

The accompanying photographs show the jobs that the pneumatic tools do in making Fleetwood's South Seas pool heater. The natural-gas-fired heater is completely automatic in operation, the improvement that let Fleetwood break into an established market. A header (merchandised as the Thermo-Flo header) which controls the amount of water diverted through the heater and the amount allowed to bypass it was the main "gimmick" that made the unit successful. Previously offered models were manually adjusted depending on the ambient temperature.

Six models of the South Seas line are offered with heat input rates from 130,000 to 600,000 Btu. All models use finned copper tubing surrounded by precast vermiculite insulation. Internal water ways are porcelainized for corrosion resistance and are easily accessible for cleaning. The unit has its own self-energizing millivolt electrical system for thermostat requirements thus requires no external power source other than the natural gas connection.

The average pool water temperature in Southern California is 75° F or higher only about 2 to $2^1/_2$ months of the year. The mild climate, however, makes it possible to use the pools the year round with only modest expenditures for heating. In the intensely competitive pool market in Southern California, the installation of pool heaters has become a big bargaining point with a number of pool builders, consequently the public is being presold and preconditioned to their acceptance. The market is considered to be a fast growing one, and Fleetwood is geared to secure a growing share. The capacity of the 6-man shop is 300 heaters per month.





STRATOSCOPE

An Unmanned Telescope In The Sky

Dr. Martin Schwarzschild
Princeton University Astronomer

AFTER successfully following through a series of unmanned balloon ascents in which the clearest pictures of the sun ever to be taken were returned to earth, Dr. Martin Schwarzschild, Princeton University astronomer, is now preparing to gather data from Stratoscope II. The goal is to obtain pictures of planets and other celestial bodies from altitudes above the distorting veil of the earth's lower atmosphere. The program is sponsored by the Office of Naval Research and the National Science Foundation, with additional support from the National Aeronautics & Space Administration. Princeton, the prime contractor, has awarded a contract to Vitro Laboratories to serve as program manager for Dr. Schwarzschild.

The primary objectives are analysis of the divisions in Saturn's rings, studies of the sudden atmospheric changes that take place on Jupiter and Venus, close examination of the gaseous nebulae between stars, and if conditions are right, the first look at the surface of Venus through gaps in its cloud cover. Chances are the objectives will be fulfilled for the balloon will rise to about 80,000 feet, above 95 percent of the earth's turbulent atmosphere.

The project can be thought of as consisting of two interrelated parts—the balloon and the payload. The former is under development at G. T. Schjeldahl Company, Northfield, Minn. Test flights with dummy payloads began in Texas in January. The next will occur this month in Minnesota. A third is scheduled for the fall. When these have been completed, instrument flights will take place, probably within the next calendar year.

The balloon, of about 3,000,000-cubic-foot capacity, is made of a new plastic lamination developed by Schjeldahl. Known as S-10, it is a combination of Du Pont's Mylar and a Dacron mesh reinforcing. It is the lightest and strongest material ever applied in balloon flights.

Tandem balloons are being used to minimize effects of ground winds during launching. This also permits extremely low ascent acceleration, a necessity because the telescope gear cannot withstand more than 0.3 g of force.

At launch, only the relatively small upper balloon will be inflated with helium. The rest of the system will be encased in a polyethylene sleeve that will keep the balloon reefed so it will not act as a sail and sweep the payload horizontally. The whole system is aerodynamically designed to be stable in brisk winds. At launch, the sleeve will be released instantly.

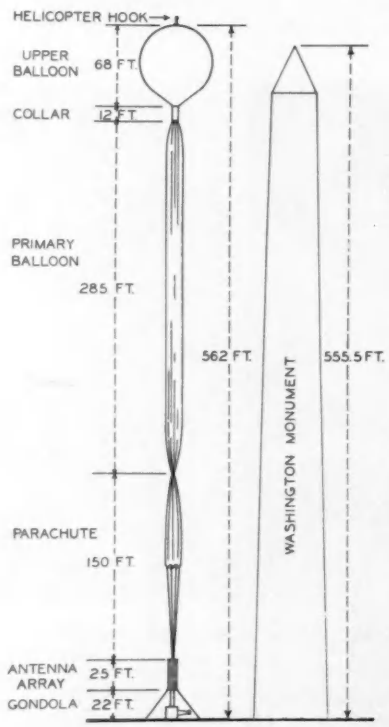
A restraining collar will separate the upper balloon from the lower and permit free flow of helium from one to another. As the balloon rises, helium will descend from the upper balloon, filling the primary one suspended beneath it. Conversely, on descent increasing air pressure will force helium from the primary balloon system into the upper balloon.

When the instrument-carrying flight is made, the balloon will remain aloft throughout the night while observations are made. It will then descend into lower and denser atmosphere where the entire unit will be captured by a helicopter-towed device.

The tandem balloon will lift the heaviest payload ever carried aloft by a lighter-than-air craft of this type. Heart of the load will be a 36-inch telescope designed and built by Perkin-Elmer Corporation on a subcontract from Princeton. The telescope is L-shaped, with one arm extending about 18 feet. In flight, the train (telescope, shroud lines, parachute and balloon) will tower more than 500 feet.

The telescope's primary mirror will be a 36-inch aperture, f/4, parabaloid. It will have a theoretical resolving power of $^1/_{10}$ second of arc. A secondary optical system will relay and magnify the image onto the photographic focal plane,

BALLOON SYSTEM Fabricated of S-10, the G. T. Schjeldahl Company-fabricated balloon has about 3,000,000-cubic-foot capacity. It will rise above 95 percent of the earth's atmospheric turbulence and dust that distorts and obscures ground-based observations. "Bad seeing" will be almost completely eliminated.



providing an effective focal length of 300 feet.

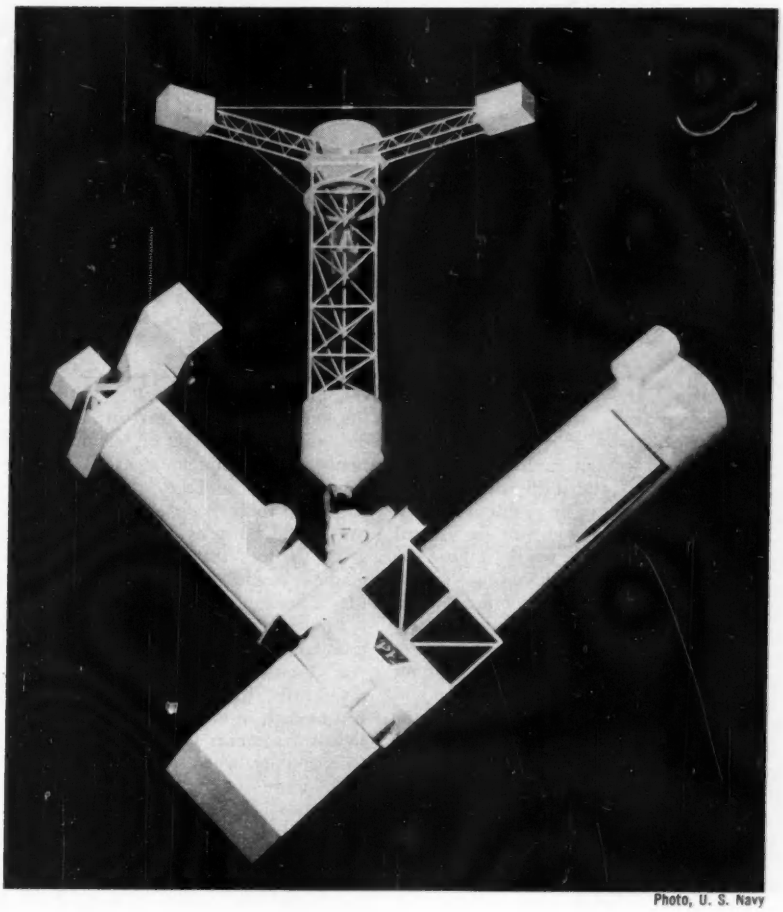
The 400-pound primary mirror is of fused silica. The mirror blank, or boule, was furnished by Corning Glass Works' Optical Marketing Department to Perkin-Elmer for surface polishing and finishing to an accuracy of $^{1}/_{1,000,000}$ inch prior to installation in the telescope. Fused silica was specified because of its near-zero thermal expansion.

Although the telescope will be controlled and roughly pointed by command signals from observers on the ground, final precise pointing will be automatic by Perkin-Elmer-designed sensing and control equipment in the telescope. Telemetered signals from the telescope will indicate its orientation with respect to magnetic north, and its elevation angle.

Stratoscope II will incorporate an improved television camera that will enable ground observers to see what the camera is seeing, to rotate the equipment to specific areas for study, and to keep the telescope in focus by radio command. Work on the new television system, which began shortly after the results of Stratoscope I were considered successful (1959), was done by Leslie E. Flory, heading an RCA Laboratories engineering team under the general supervision of Dr. Vladimir K. Zworykin at David Sarnoff Research Center, Princeton, N. J.

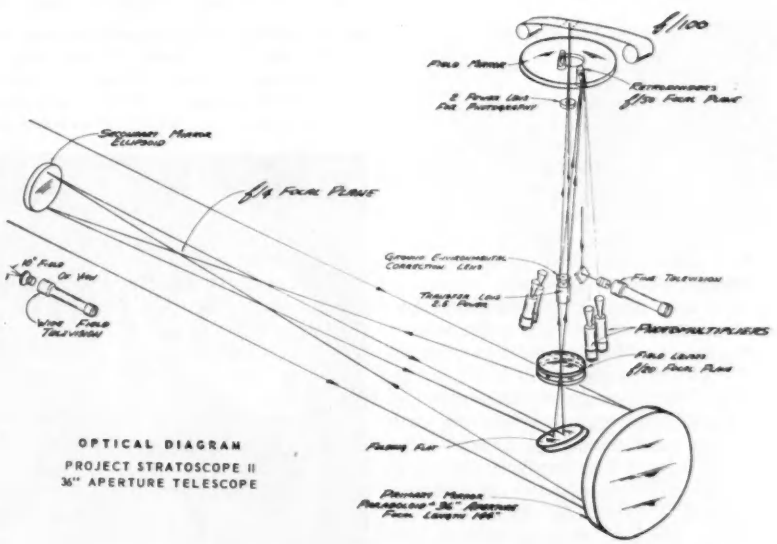
When the telescope pointing is narrowed to within 1 minute of arc of the correct position, a ground signal will actuate an electronic-optical servo system on the telescope. This will accomplish final aiming. When the telescope is precisely pointed, ground command will activate the associated camera.

Stratoscope II stands on the threshold of great advances in astronomy. Its success depends to a major degree on the enthusiasm, the ingenuity and the keen capabilities of each supporting agency and company.



Photo, U. S. Navy

PAYLOAD Shown above is a model of Stratoscope II. The 36-inch telescope was designed and built by Perkin-Elmer Corporation. As can be seen in the sketch below, the telescope is L-shaped with one arm extending 18 feet. The primary mirror is of fused silica, specified because of its near-zero thermal expansion. It was furnished by Corning Glass Works, pioneer in forming fused silica boules. Every picture taken will be a good one because of the ground-balloon control system.



OPTICAL DIAGRAM
PROJECT STRATOSCOPE II
36" APERTURE TELESCOPE

this & that

Ending Irritation From Flats

If the glove compartment in your car is filled with the worthless paraphernalia that invariably collects, it is time to clean it out and replace the trash with a bottle of air. Nothing can be so annoying as a flat tire, especially when you are dressed for an evening on the town. Fixing the flat can rumple more than your clothes. However, the bottle of compressed air that is now on West Coast markets, is a handy solution for people in such a predicament. It inflates a flat without tools or pumps. A coupling on the end of the bottle's nozzle is screwed into the air valve on the tire. When the connection has been made, air enters the tire—along with a butyl chemical mixture that seals small punctures—giving enough tire pressure to get the limping car to a filling station.

★ ★ ★

Gas-Powered Cork Remover

Once upon a time a few thousand years ago a genius collected within a vessel the precious juice of many grapes. He sealed the container and waited patiently. After an appropriate interval, he removed the seal and drank of the fluid. Since first used in Edward I's day, one special type of seal has stood between the wine lover and the nutty goodness in the bottle: the cork. It is needed to keep air and bacteria from the liquid, but as the wine becomes aged, so does the stopper. When the moment comes when the cork's useful life is finished, the cork resists. Always it comes out stubbornly and often it crumbles, breaks, lets the corkscrew tear loose, or otherwise behaves unpleasantly. The wine drinker may find bits of cork in his glass and may eye unsightly fragments floating in the bottle. Occasionally, when a bottle gives up its cork more begrudgingly than usual, somebody is sprayed.

Now appears on the scene a device called the Cork-Ace. It is a carbon dioxide powered cork remover that works this way. A sharp, hollow needle is inserted through the cork into the space between the cork and the wine. A valve in the grip is pressed and a small quantity of pressurized carbon dioxide is injected. The gas pushes the cork out of the bottle intact. Denis Farandatos, a New York restaurant owner, perfected the Cork-Ace after some 10 years of work with it. He hit on the basic idea after observing that thumping a bottle against a wall could help dislodge a cork.

The carbon dioxide is stored in the grip of the instrument in a conventional CO_2 cartridge, and one cartridge is said to be good for a minimum of 30 corks. Oenophilists (wine lovers) state the momentary contact of the tasteless, odorless gas does not affect the taste of the wine. One has gone on to say that Mr. Farandatos ". . . has done more for wine than anyone since the days of his Greek compatriot, Bacchus, and he deserves the hero's wreath of vine leaves."

★ ★ ★

Mexico's Pneumatic Buildings

Almacenes Nacionales de Deposito, S.A. (ANDSA) has entered the fast-swelling ranks of air-supported structure users. The reason, to resolve the problem of temporary storage of grain in Mexico. Previously, much of the Mexican harvest has been piled in fields and ruined before shipment to a permanent warehouse. Use of the air buildings will permit the government to store grain with little or no loss from the elements and at a very low cost. Forty-seven such structures, with a total volume of nearly 4,000,000 cubic feet, have been built in the U. S. for the Mexican firm. The vinyl-coated nylon buildings, developed in the States, were designed and built by C. I. D. Air Structures, Chicago, Ill., and by Childres Canvas Products, Inc., Dallas, Tex., using 42,000 yards of a special material known as Tuff-Tarp. This new fabric was produced by Farrington Texol Corporation, Walpole, Mass.

Specially designed conveyor ports have

"Them Bones, Them Bones"

A DUMMY with a flat head, fleshless plywood bones and a trick spine helps prevent back injuries. Even though he has a wooden head, he's no dummy when it comes to getting his point across. The device is part of a long-range program to teach proper lifting techniques to employees of Dayco Corporation. Without a word he lets workmen see for themselves that even heavy objects can be lifted without injury or strain.

Less than $2 in materials and about $10 in labor have been invested in the weight-lifting chap. The device works on a simple leverage principle. There are movable joints at the ankles, knees, hips and shoulders. The backbone is a series of wooden blocks held together by elastic strips. The employee provides the lifting power by means of a handle at the base of the dummy's spine.

With the load properly placed, the dummy's knees are bent and the back is straight—almost vertical. Pressure applied to lift the load causes maximum strain to be placed on the dummy's legs instead of the back; he reaches a standing position without mishap. But when the load is too far forward, the dummy's back is forced to bend putting it under a strain. When the employee tries to make the dummy lift the load in this position, the extra stress causes the backbone sections to separate.

The abrupt misfortune that befalls the wooden figure is startling but is not without its comical side. Virtually every person seeing the demonstration for the first time is inclined to laugh when the backbones part company. However, the laughter is quickly replaced with the sobering realization that this is what frequently happens to the human spine. The lesson goes home with dramatic—and sometimes chilling—effect. When it is considered that about a fourth of all disabilities suffered by American workmen are caused by improper handling of materials, the need for an educational program in correct lifting is obvious.

been built into the huge structures to permit the entry of grain on conveyor belts. There also are openings for trucks and personnel. The buildings are kept upright by gasoline-powered blowers since electricity is not available in many of the areas where these buildings are used, that is, near harvesting sites. The buildings are firmly fastened to the ground, and reportedly can resist 70-mph gales or gusts to 90 mph.

★ ★ ★

Mild Steel Welding

Air Reduction Sales Company has developed a new process called Aircomatic CO_2 Sprayarc that combines the use of carbon dioxide with a low alloy steel welding wire to join mild steel. The process employs the economies of CO_2 welding with features of gas shielded arc welding and

requires no special equipment. Advantages offered by the process are spatter-free welding, open arc, spray-type transfer, good weld appearance, sound welds, economical deposition rates, continuous wire feed for high work factor and low cost CO_2 shielding gas. Laboratory data and field trial results indicate essentially no spatter is produced when proper techniques are used. Sound welds can be made with direct current, straight polarity using CO_2 shielding gas. The process provides ease in welding with a visible arc length of about $^1/_8$ inch. About 32 v are recommended for most work. Typical applications for the new process are in tubing, landing mats, die posts, piping, car frames, compressor casings, pressure vessels, farm machinery and machine mountings.

★ ★ ★

Spectral Shift Control

The Atomic Energy Commission has notified interested parties that it plans to authorize Babcock & Wilcox Company to operate the company's Critical Experiment Laboratory with a special control system known as spectral shift. In concept, the spectral shift control reactor (SSCR) would use varying mixtures of ordinary heavy water as coolant, moderator and partial control agent. The idea is that, by varying the concentrations of light and heavy water as a moderator it is possible to compensate for reactivity changes by taking advantage of the change in neutron energies which occurs in the core of a reactor as fuel is consumed and poisons built up. (The change is known as spectral shift.) At the beginning of core life of an SSCR, higher concentrations of heavy water would be used. This would hold down the number of fissions caused by thermal neutrons, but would allow epithermal neutrons to cause fissions and also to be profitably absorbed in fertile material to produce more fissionable material. Then, as fuel is consumed and poisons generated, the reactivity loss would be compensated by increasing the proportion of light water. This would allow more fissions by thermal neutrons, increasing the reactivity correspondingly. The major advantages thought possible from the SSCR are longer fuel lifetime, more uniform power distribution, better neutron economy, greater production of fissionable material and minimal control rod requirements.

★ ★ ★

The Easy Life In San Diego

San Diego, Calif., has become a city of moving sidewalks. It has six of the step-saving devices, more than any other metropolis in the world. Newest additions are twin units that carry shoppers from a mammoth underground parking area to the shopping level of the 80-store Mission Valley Center in northern San Diego. Designers Stephens-Adamson Manufacturing Company engineered the Speedramp units to transport 7200 passengers an hour. A safety factor is a "floating comb" that runs between closely spaced ribs of special belt produced by The Goodyear Tire & Rubber Company to prevent trapping of high heels or clothing at the ramp exit. A companion microswitch assembly halts the belt and applies a dynamic brake if even a small object slips underneath the comb.

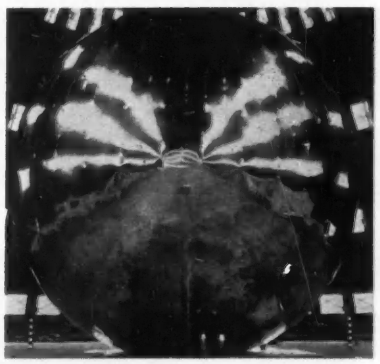
★ ★ ★

Sun Storms Slowdown Echo I

Studies of variations in the orbit of Echo I have revealed that on November 12, 1960, at about the time of a severe storm on the surface of the sun, the atmospheric drag acting on the satellite suddenly doubled. This caused a corresponding decrease of 2 seconds per day in the satellite's orbital period. The high drag persisted for several days then returned to its original level. (Echo I was launched by NASA on August 12, 1960, to reflect radio waves beamed at it by powerful transmitters. The shiny, 100-foot-diameter, gas-filled ball—an identical balloon is shown in the picture—took an almost circular orbit at an average altitude of approximately 1000 miles above the earth; it became an easily visible sight for satellite watchers as it passed across the night sky.) The solar disturbance of November 12 was the most severe since a great storm in 1956. Two giant flares and several smaller eruptions rose from the sun's surface within a few days. When the particles and radiation from such solar disturbances reach the earth they cause several things. The increased number of charged particles in the atmosphere weakens and distorts transmission of radio waves. This particular storm blacked out international radio communications for 2 days. The storms also produce eruptions in the earth's magnetic field, create brilliant auroral displays, and partially empty and refill the Van Allen belts of charged particles in the earth's geomagnetic field.

Two NASA scientists at Goddard Space Flight Center, Robert Jastrow and Robert Bryant, made the orbital studies. They believe that the higher drag acting on Echo I resulted from an increase in the density of the air through which the satellite traveled. When particles and radiation from solar flares strike the atmosphere heat is produced. The heating causes a slight outward expansion of the lower atmosphere. Consequently there is a great increase in the density of the very thin air at Echo I's high altitude.

It has been known previously that the entire upper atmosphere rises and falls—"breathes"—in response to the general level of storminess on the surface of the sun. But the response of a satellite to a



specific solar flare has been noticed only once before. The two scientists believe that the detection of the solar storm effect on the Echo I orbit may provide a clue to the mechanism by which solar particles and radiation heat the atmosphere. This is one of the basic problems facing physicists seeking to understand the influence of solar "weather" on earth weather. A summary of the studies was reported in a National Academy of Sciences IGY Bulletin.

DISCRIMINATING selection of air tools specially suited to each assembly operation is paying dividends in both production speed and product quality at the Decatur Works of York Division, Borg-Warner Corporation. In some cases, special multiple tools are designed for the job; in others, individual fittings are used with standard tools. For the most part, though, standard tools have been found with the precise speed, power and torque control needed. York's process engineers studied the full range of versatile pneumatic tools and made selections based on tool quality and performance characteristics.

One problem in building hermetic compressors for room air conditioners was assembly of the upper bearing to the body. Since the body is heated and the bearing held in a shrink fit, it is imperative not to cock the bearing in running down the three $^{1}/_{4} \times {}^{3}/_{4}$-inch hex-head bolts required. The torque specification called for 7 to 9 foot-pounds. It was met satisfactorily with an Ingersoll-Rand Size 5020T torque-control Impactool running down the bolts individually. Still it was difficult to avoid cocking. The solution was found with the introduction of Size YE3 multiple spindle assembly machines. The units run the bolts simultaneously to selected torque and pull the bearing in evenly, always parallel to the crankshaft. Product quality was the prime consideration here, but York received an extra dividend in faster assembly.

The 5020T Impactools were not discarded. With torsion bars reset to meet a 19- to 22-foot-pound specification, they now find work running eight $^{5}/_{16} \times 1{}^{3}/_{4}$-inch cylinder head bolts, shutting off automatically when they reach the preset torque. The torque control took over this job from straight Impactools and again improved assembly quality.

These applications are more conventional than some in the division. For example, a torque-control tool is found where tests are made on press fits of the stator in the body of the hermetic compressor. Assembly procedure is to heat the body, drop in the stator, then cool the body so it holds the stator in a press fit. Quality control engineers determined that the fit should be tight enough to withstand a 75-pound force. To verify the fit, the assembly is simply placed in a special jig that holds the body while a Size 5040T torque-control Impactool tries to rotate the stator. The tool's torsion bar is set to turn off the tool when torque exerted reaches 75 foot-pounds. If the stator has not moved, the fit meets the quality standard.

The division's engineers take considerable care in testing new tools thoroughly to determine their suitability for such jobs as this. For example, they ran tests on the Size 5040T Impactool for 5 days, assembling extension housings to cases. According to specifications, bolts were to be run to a torque between 28 and 38 foot-pounds. Each day 100 bolts were checked with a hand torque wrench to verify the accuracy of the automatic Impactool. On 4 days, all bolts checked were within the specified range. One day, 98 of the 100 were in range, the other two a little high —performance accuracy of 99.6 percent.

Moving to the automotive compressor line, one can see air screw drivers used as nut runners. The operation: subassembly of valve plates. Ingersoll-Rand screw drivers are used to run 10-24 cap screws to a torque of 30-inch pounds because these tools not only are fast and lightweight, but have accurate, adjustable torque control clutches even in this low range. The same type of screw driver, but fitted with a special guide and blade, is used to turn the slotted tube of an oil screen adapter to a torque of 30 inch-pounds.

To assemble the choke to the electric panel, Borg-Warner again uses I-R screw drivers as nut runners. The size used is compact and lightweight (girls handle this operation), yet is fast. There is plenty of power to run the 8-32 bolt to 10 inch-pounds. Again, torque control was a considered advantage. Pneumatic screw drivers are used conventionally to drive No. 8 Phillips screws in assembling the electric panel, evaporative plenum, fresh air and exhaust doors, top covers, name and escutcheon plates.

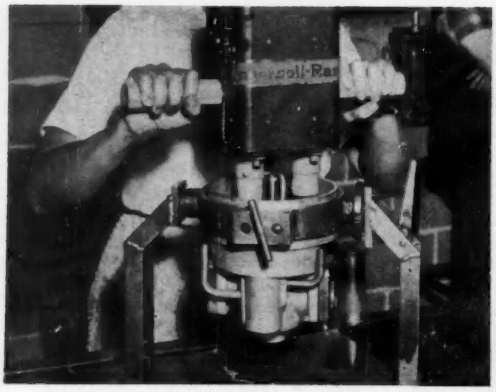
Holding the rear cover plate to the body of the automotive compressor are eight flat-head screws. A tight fit is required; torque is not critical (50 to 120 inch-pounds is permissible). Power and speed are needed, however. A Size 502B Impactool with screw driver bit is employed. Tool speed is such that an operator can assemble 107 units (running 856 screws) in an hour.

Even riveting hammers have important functions. At one time, a hammer and hand punch were used to force a tube and screen assembly into the cylinder head. Not only was the job hard and slow, it resulted in considerable loss due to damaged parts. With the currently used riveting hammers, the task has become so easy women are often assigned to do it. And the production rate has been reportedly doubled. Because the force of the hammer's blow can be controlled, distortion of heads is prevented.

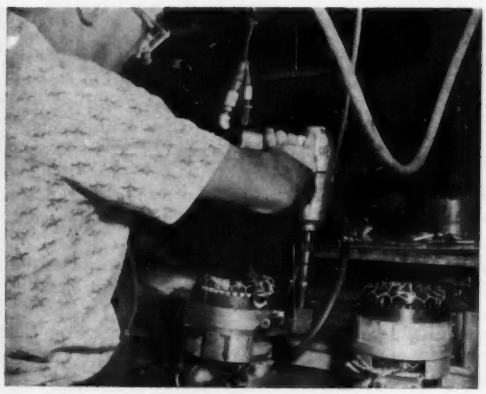
The shop had similar experience in driving the roll lock pin on the wrist pin connecting rod-piston assembly. With a hand hammer, the job was also slow, difficult and hard on parts. Pneumatic riveting hammers make it one that can be done quickly and without piston distortion.

The tools used at Decatur are as varied as the jobs that require them. It is not surprising even to find a pneumatic angle wrench fitted with a tap removing welding flash from holes in the automotive compressor's bottom pan. The angle tool is convenient for the operator to hold and has one control to run the tap in, a second to reverse the tool and remove the tap.

Whether the tool is called a screw driver, assembly machine, drill, riveting hammer or Impactool, it is sure to be specially suited to the job it performs at the York Division. The result is efficient production of quality products.



1



2

EXPLORING THE VERSATILITY OF AIR TOOLS

1 Three-spindle Ingersoll-Rand YE3 multiple nut runner pulls the upper bearing into the body of a room air conditioner compressor in perfect position for a shrink fit.

2 Press fit of stator in body of hermetic compressor is checked. Body is held in special jig while turning force is applied to stator by an I-R Size 5040T torsion bar torque-control Impactool set to shut off automatically at 75 foot-pound torque.

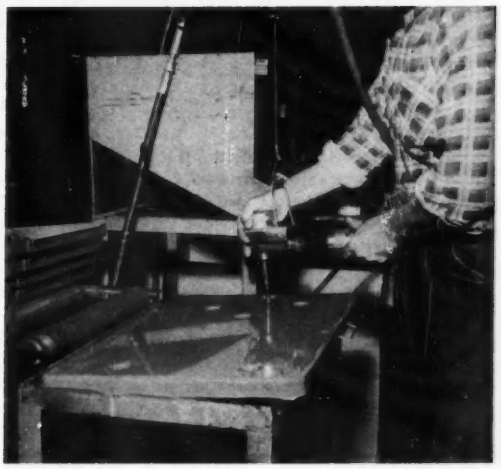
3 On the automotive compressor line, Borg-Warner uses Size OOB2LC21 Ingersoll-Rand screw drivers as nut runners in subassembly of valve plates because they provide accurate torque control in desired range.

4 An I-R Size 502 Impactool with screw driver bit provides the power and speed to drive eight flat-head screws that hold the rear cover plate to the body of automotive compressor.

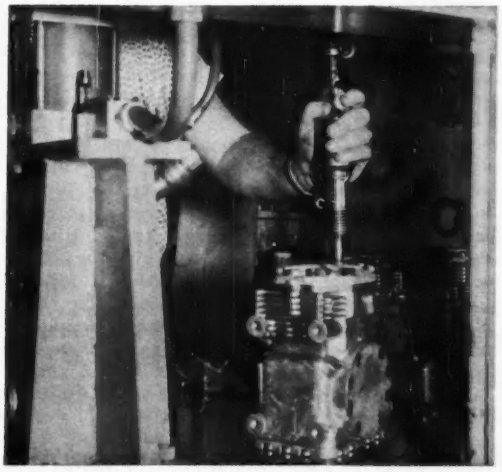
5 Replacing a hammer and hand punch, this AVC11 air-powered riveting hammer drives the roll lock pin into position quickly and easily, without distortion of the piston.

6 Another air riveting hammer forces a screen assembly into the cylinder head. Controlled blows have doubled production and virtually eliminated damage of parts.

7 To remove welding flash from six holes in the automotive compressor's bottom pan, the operator uses an Ingersoll-Rand Size OBR1N air angle wrench with tap. One control runs tap in; a second, out.



7



6

3

4

5

The Possibility of Nuclear-Powered Rockets

CHEMICAL-BURNING rockets, because of their comparatively low thrusts, limit man's ability to hurl objects into the blackness of outer space. Only relatively lightweight payloads can be carried and only the closer fringes of space can be reached. To solve this dilemma in propulsion, scientists may have to turn to nuclear power.

Current rocket fuels are rated by their specific impulse (thrust performance per unit of fuel flow). Specific impulse (I_{sp}) times the weight flow of propellant in pounds per second equals rocket thrust (see *Compressed Air Magazine*, August 1960). Specific impulse values are relative. By today's standards, an I_{sp} value of 300 seconds indicates an extremely good fuel. Hydrogen-fluorine mixtures are best with I_{sp} values of 375 seconds.

Payloads can be increased remarkably with very small increases in specific impulse values. Obviously the specific impulse must be increased for vehicles scheduled for interplanetary service. One plan is for a nuclear-powered space vehicle with superheated hydrogen as the propellant. In other words, the hydrogen will be heated by nuclear energy and exhausted in the rocket. Even with anticipated power losses, the specific impulse would be 750 seconds.

So far, based on present knowledge of materials and nuclear science, the major drawback in atomic-powered rockets lies in the reactor. In such a rocket, the reactor required to harness enough energy release to provide power for extensive space travel would have to be about the size of Boulder Dam. Yet, if the scheme is to be practical, all the necessary power must be contained in a unit that is no larger than a household deep freeze. At the same time it must provide the thrust that will not only get a space craft off the ground in a tremendous burst of power, but continue to supply steadily the vast power necessary for prolonged flight.

One nuclear-powered method advocated by Dr. Edwin L. Resler, Jr., of the Cornell University Graduate School of Aeronautical Engineering, and Dr. Nicholas Rott, formerly of Cornell and now professor of engineering, UCLA, calls for the use of a regenerative helium cycle with a heat sink at the low temperature of liquid hydrogen. The use of hydrogen and helium in the Resler-Rott scheme apparently meets the requirements necessary for a relatively small, but efficient, propulsion unit. In addition, the power plant requires a turbine and an electrical or mechanical drive.

At the Second International Congress of Aeronautical Sciences last year in Zurich, Switzerland, it was said that this closed-cycle machine combined with other proposed units would give an extremely high relative thermodynamic efficiency.

A previous suggestion for transmitting nuclear energy to the hydrogen propellant involves direct heat transfer. It is best for this purpose to carry liquid hydrogen under low pressure to make the large containers that are required light in weight. The liquid hydrogen is then pressurized before it enters the reactor. This technique allows the smallest possible heat exchanger. A liquid pump that is necessary in the plan has only a small power requirement. It would be possible to lead the hot high-pressure hydrogen gas coming from the reactor into a turbine. Then the gas would be reheated in the reactor after it leaves the turbine. Finally the turbine power (less the small power for the liquid pump) would be dumped into the gas, which therefore would become hotter than the maximum reactor temperature. The best way of dumping is probably by use of a compressor (see figure 1).

The greatest difficulty lies in reheating the gas after it leaves the turbine. The required heat exchanger would be large and impractical. However, the Resler-Rott scheme avoids this. According to Professor Resler, "The new scheme calls for a closed-cycle regenerative gas turbine using helium working between the reactor (the heat source) and the liquid hydrogen (the heat sink)." The power of the gas turbine is dumped electrically into the hydrogen coming out of the reactor. The modified Resler-Rott scheme is shown in figure 2.

This closed-cycle regenerative gas turbine is based on an invention of professors Ackeret and Keller, referred to in standard textbooks as the AK process. In the Resler-Rott system, the AK unit shown in figure 2 would be filled with high-pressure gas—in this case helium since its condensation temperature is below that of hydrogen.

The counterflow heat exchanger needed in the AK unit is a critical part of the system, according to its designers. It is assumed that the exchanger consists of a bundle of pipes carrying high-pressure helium. The hot helium leaving the turbine is carried in the space between the pipes and the regenerator wall. It is cooled by the helium inside the pipes returning from the liquid hydrogen.

The Resler-Rott program is not science fiction. It has real value when it is considered that the Atomic Energy Commission and the National Aeronautic & Space Administration have announced that they are co-operating in a joint effort to develop a nuclear rocket engine that will be launchable shortly after 1965. It means that enough power will be available to thrust a man and such necessary baggage as food and scientific instruments, in a tough air- and radiation-proof chamber with several tons of life-supporting materials, not just to the moon, 240,000 miles away, but to, perhaps, Pluto—a distance of 2.6 billion miles.

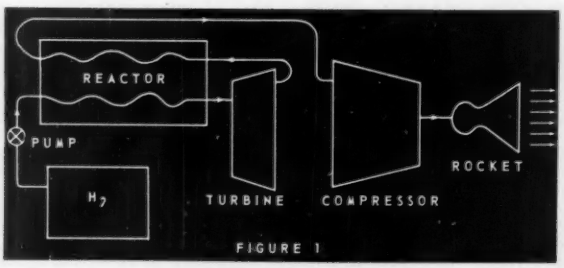


FIGURE 1

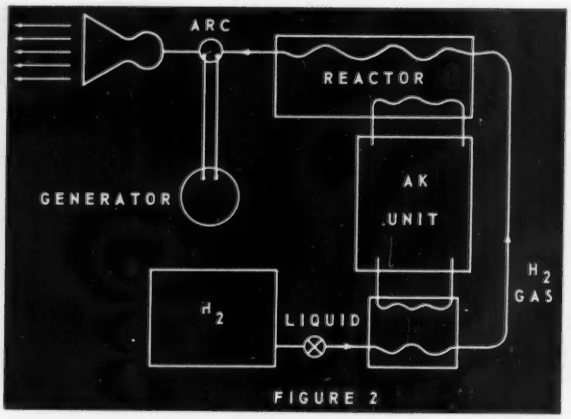


FIGURE 2

NUCLEAR ROCKET PROPULSION Figure 1, left, shows a reheat scheme for a nuclear-powered rocket using hydrogen. Figure 2, right, is the new scheme. A closed-cycle gas turbine (AK unit) works with the reactor as heat source and the liquid H_2 as heat sink. Power generated is dumped into the hydrogen.

EDITORIALS

Chemicals—A Guidepost

RECENTLY David H. Dawson, a vice president and director of E. I. du Pont de Nemours & Company, spoke to financial analysts about the future of his company and of the chemical industry as a whole. Federal Reserve Board indices show that output of the chemical industry has, in the post-World-War-II years, grown at a rate about double that of the nation's total industrial production. In commenting on the chances for a continuation of this pattern, Dawson said, "Despite talk of the industry's increasing maturity, and despite the obvious fact that it is patently absurd to expect such a trend to continue for the indefinite future, I am forced to conclude that it is reasonable to expect that it will continue for at least another decade."

He offered a number of reasons for his prediction, among them discerning analyses of markets past and future, and also commented, "The chemical industry in the past has demonstrated great vigor in research, continual emphasis on farsighted management, and *ability to control costs by technological improvements.* In the long run it would be strange indeed if these capabilities did not convert its anticipated sales growth into increased earnings." The italics are ours for we believe that his statement has an importance that justifies emphasis.

Economists are agreed that the next 10 years—the "Soaring Sixties" that are still struggling to get off the ground—will indeed be a decade of vastly expanded markets. The activities in the market place, so say the seers, will result in sales for someone, but it will be a competitive duel down to the finish line with quality, performance and price the weapons. And therein lies the importance of converting "anticipated sales growth into increased earnings." Sales are fine, expansion wonderful, only if a just and attractive return on investment can be realized.

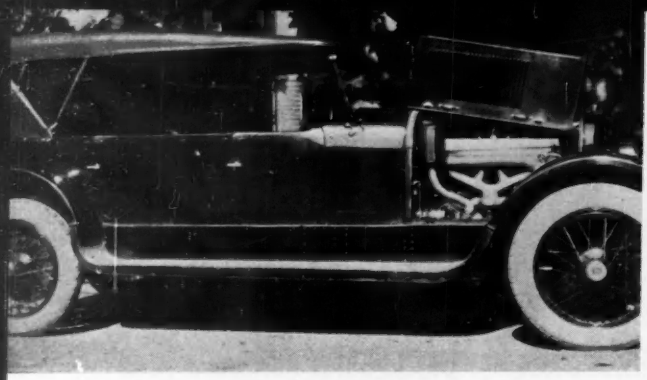
The chemical industry, perhaps more than any other, relies on compressed air and gas equipment and on machines that move fluids from one place to another. And to us it seems quite significant that a major part in programs to control costs and sustain the industry's growth pattern is based on the factor of improvements in technology. Hand in hand with such advances, of course, must have come equivalent advances in compressors, pumps and vacuum equipment.

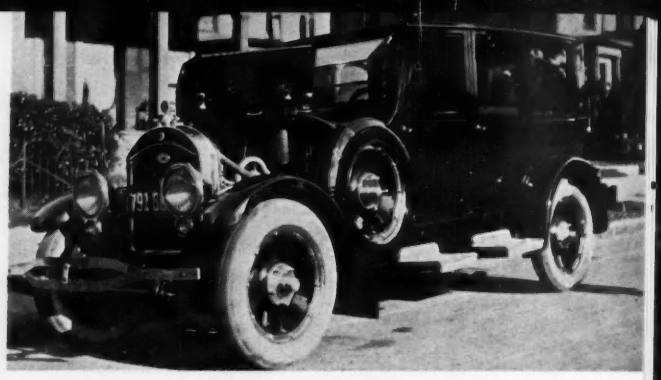
The lessons learned by the chemical industry must be and are being learned by other industries. We'd like to emphasize that the advances in air, gas and vacuum technology that have aided the chemical industry are oftimes available for transplanting. There are numerous examples of this, and they have proved that the benefits can be as great or even greater. Chemicals, as an industry, gets along with fewer production workers than many other less highly automated ones, thus savings in time, labor and ultimately in final costs can be even greater where more workers are involved in the manufacture or processing of goods.

Keep Thinking

INDUSTRIES throughout the country are now urging their employees to take home with them some of the safe practices that they have so carefully acquired at work in mines, mills and shops. Safety statistics show that seven out of ten fatal accidents occur away from work, as do more than half of all injuries. Thus most of us are considerably safer at work than in the home. Indeed, insurance companies that used to charge certain types of workers an additional premium for so-called hazardous occupations have recently dropped all but a bare minimum of these. Actuaries point out that continual training and constant emphasis on safety have made many of these jobs safer than the average for all of industry.

There is a great deal of pathos, says one safety expert, in the fact that most of today's accidents are caused by thought lapses. Accidents such as stepping back off a ladder to admire a paint job claim so many victims that were they not so tragic, they would be humorous. One safety slogan that seems to cover this aspect of carelessness (even foolishness) is *Keep thinking, and stay alive.* The vacation season, now in full swing, has been selected by many industries as the most vital time to sell this approach to safety away from the job. By so doing they are performing a vital service and, hopefully, may help to cut down the tragic toll afflicted on ourselves. Indeed, it would seem that industry is serving well its own interests, for who can compute the loss to a firm of a well-trained and loyal employee?





GHOSTS Hoods of the two venerable automobiles above are opened, showing the early Dollinger air-intake filters mounted on the firewalls. The left car is a 1920 Marmon and the proud vehicle at right is a 1919 Cole.

Forty Years **of Filtering**

Alec Lewis-Morgan

WITH a sigh the engineer reached for the scissors and proceeded to snip away at the green and gold felt of his old Clarkson Tech pennant. He had searched through the whole house and this, unfortunately, was the only scrap of cloth that seemed to have the right qualities. He smiled and thought the old alma mater would never know how well she had served him. After cutting the felt into a long strip a few inches deep, he mulled a moment, then began giving it an accordion fold, like a string of picture post cards. Next he securely clamped the felt around the outside of a short length of metal pipe so that each fold stood out radially from the pipe core. Lewis L. Dollinger dropped the whole affair inside a perforated metal can. He put on the lid and held his first air filter up for inspection.

This took place back in 1920 and the filter worked fine for cleaning intake air to an oil company's truck. Lewis Dollinger and the company that bears his name are still making air filters today, along with many other kinds. Dollinger Corporation, Rochester, N. Y., had net sales last year of about $2,600,000. From this first rudimentary felt-filled can the company has branched out to manufacturing sophisticated air-intake units for internal combustion engines in general, for compressors, blowers, motors and generators. It builds pipeline models that clean water, oil and dirt from lines going to air tools, pneumatic controls and vacuum pumps. Dollinger-built gas filters taller than a man wipe impurities from natural gas pipelines. Another type removes foreign matter from oils, water, chemicals and coolants. Another cleanses hydraulic oils and lubricants.

A history of the company, which passed its fortieth year of existance this June, is chiefly a history of the business life of the senior Dollinger and, more recently, of his sons, for the company is still owned almost completely by the family. Today the founder is chairman of the board and retired. His eldest son, Lewis, Jr., is president and in active charge of the company's operations. Two other brothers, F. Leslie and J. Bruce, serve as vice presidents and William T., the fourth brother, is controller.

The senior Dollinger was well prepared to recognize the need for and then build one of the first air filters for automobiles and trucks. After completing college in civil engineering in 1911, he went with the New York State Highway Department for a few years as a road designer. One of his earliest tasks was the engineering work for the first highway built between two upstate towns, Dansville and Hornell. Next, he moved into private industry as service manager for the Cleveland Tractor Company, Cleveland, Ohio. Tractor engines, he observed, showed excessive wear. He speculated the reason for this was that they worked in heavy clouds of dust. Something was needed to clean the air the engines consumed and prevent grit from collecting inside.

A short while later Dollinger left the tractor concern and moved to the Rae Oil Company in Rochester but continued to think about the need for an air-cleaning device. He never seemed to have time, however, to translate his ideas into an actual filter. His chance finally came in the form of a 2-week rest after leaving the Rea job and before starting as local sales manager for a national oil company. It was probably the most important period of "inactivity" in his career. It was then that he came upon his college pennant while turning the Dollinger household upside down looking for a bit of cloth that had a dense, tight fiber but still let air pass through freely. After making the filter he drove over to the Rae Oil Company's garage and bolted the contraption onto one of the delivery trucks. After a trial period of several months the engine was torn down and inspected. For the number of miles the vehicle had traveled, the pistons and cylinder walls showed an amazingly small amount of wear.

Word about the filter got around and shortly other companies were asking Dollinger to build filters to protect the engines of their truck fleets. In 1921 a new company, Staynew Filter Corporation, was formed to manufacture the invention. The idea of a dry, cleanable element was expressed by the coined word, "Staynew." These early units have been immensely improved by now, of course, but Dollinger filters have continued to be the dry type with clean-

able elements. Many still use felt media. It is the company's feeling that a dry, permanent type offers the best over-all solution to filtering, and, in the long run, saves the user money. Except for one specialized filter, no oil films or other liquids are used in any of the company's line. One advantage of a dry filter is that the longer it is used, the more efficient it becomes.

Dollinger's main problem in these first days of a rapidly expanding automotive age was not selling his product but promoting an idea. People were uneducated to the concept of filtering and how it prevented engine wear. Spreading this dictum was becoming increasingly important, Dollinger believed, for engine speeds were growing in the quest for added horsepower. With this concept in mind, the young engineer gave his air-intake filter the name Protectomotor, a trademark still used by the company. To further impress on his customers the necessity of keeping dirty air from engines, a homely but graphic motto was adopted: "A Motor without a Protectomotor is like a Watch without a Case." In its first 2 years the young concern spent some $14,000 in advertising from $20,000 gross sales. It advertised nationally. A full-page ad in a May 1925 issue of the *Saturday Evening Post* pulled 9000 inquiries. Sales resulted from 40 percent of these.

Protectomotors were soon to appear on many automobiles: Auburn, Buick, Cadillac, Chandler, Chrysler, Essex, Ford, Hudson, Hupmobile, Oldsmobile, Packard, Pierce-Arrow, Plymouth, Studebaker and Willys-Knight.

An export program was early put in motion and a dramatic use of the Dollinger filters appeared in 1925. French government Citroens traveling the dusty roads of the Sahara desert were equipped with Protectomotors. So was another Citroen used by a magnetic observatory in the wastes of western Australia.

Industrial uses of the filters were appearing at about this time also. In 1924 Dollinger sold air-intake units to Ingersoll-Rand Company to be installed on portable compressors built at the concern's Painted Post, N. Y., plant. Industrial filters also were shipped to the FIAT automotive plant in Italy and to the gold mines in South Africa.

OLD COMPRESSOR Staynew filters were used on the intakes of both the engine and compressor of this mid-1920's vintage Ingersoll-Rand portable. The first filters Dollinger sold to an air compressor manufacturer went to Ingersoll-Rand in 1926 for use on the company's portables built at the Painted Post, N. Y. plant.

Through the years Staynew Filter Corporation (the name was changed to Dollinger Corporation in 1941) gradually came to spend a good deal of time solving intricate filtering problems brought to it by various industries. This is reflected in the complexion of the company today. Although the concern offers several lines of off-the-shelf units, it is well organized to design and build the one-of-a-kind filter to a customer's specifications. It is getting back into the field of high volume standard-unit production but wants to retain its lucrative and prestigious business of custom work for industry in general.

Here, listed by years, are some products that Dollinger Corporation feels to be significant contributions to the field.

1928 The first filter for removing pipe scale, oil and water from compressed air was designed.

1932 A set of process filters was built for filtering hot and cold air and ammonia gas. These units were used in the manufacturing process of the explosive TNT.

1937 An absorption unit was built specifically to protect air instruments.

1939 A line of liquid filters was introduced to remove water, oil and chemicals.

1941 A line of combination centrifugal and dry-type filters was developed for cleaning natural and manufactured gases for use by transmission lines and utility companies.

World War II British Spitfire and Hurricane fighter aircraft were equipped with Dollinger air-intake units. Those so equipped flew from fields in North Africa where dust and sand were special threats to engine performance during landing and take off.

Also during the war, Dollinger produced a tiny 14-ounce aluminum filter for antiblackout suits used by U. S. pilots. The component prevented oil from seeping into lines running to a small air compressor.

About 400 Dollinger filters were used by Atomic Energy Commission scientists in the process of manufacturing the atomic bomb at the AEC facility, Oak Ridge, Tenn.

1950 An improved vacuum filter was introduced. Having a dry-type woven glass and felt element, it was used in vacuum melting of magnesium.

1957 The first dry filter was introduced for use on tank auxiliary engines.

1958 An improved sump filter for hydraulic systems was developed; it has a 1-piece metal element.

1959 The first dry filter for use on main engines of a military vehicle was produced. This unit is used on the U. S. Army's M-113 all aluminum person-

THE SATURDAY EVENING POST

99 9/10 % EFFICIENT

PROTECTOMOTOR

Perfect Positive Protection

99 9/10 % EFFICIENT

keeps your motor fit

until the rest of the car is worn out

Five Years of Proof

Protectomotor Prevents Wear

Protectomotor Reduces Carbon Deposits

Protectomotor Muffles Carburetor Noises

Protectomotor Is Standard Equipment

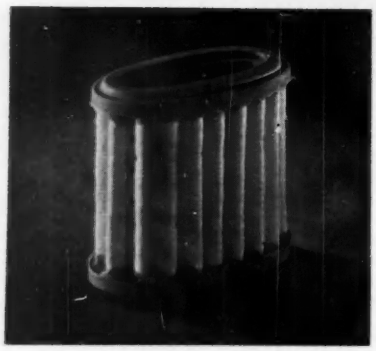
Your Motor Needs Filtered Air

Important

STAYNEW FILTER CORPORATION
ROCHESTER, N. Y.

A Motor without a Protectomotor is like a Watch without a Case

EARLY AD This advertisement appeared in the May 16, 1925, issue of "The Saturday Evening Post" and drew 9000 inquiries. Besides stressing the Protectomotor's advantages, the ad tells the reader "Your Motor Needs Filtered Air," as part of a program to educate motorists to the concept of filtering. It also says the equipment is suitable for "electric motors, air compressors, pipe organs and buildings."



THE TALL AND SHORT OF IT

These two pictures give an idea of the range of filters that Dollinger manufactures. The CVH gas unit above is the largest product the company has ever built; one of two inserts is shown on the skid. At left is a 5 cfm cartridge with molded plastic end seals for an OEM filter. It is a mere few inches in height.

nel carrier and is unique in that the upper part of its housing is aluminum and the bottom is glass fiber.

1960 An improved dry filter was designed for use on all air-breathing machinery.

Perhaps the most significant recent development of the company is a plastic-molding process that seals the ends of a filter's mesh fins into one piece. Dollinger engineers worked 2 years in perfecting the idea and in designing and building the molding apparatus. The plastic is used on the hydraulic sump filter line designed for OEM markets. With the plastic molding, applied by a die injection system, filters can be produced at a drastically lower cost. Earlier filters of this type required slower and costly individual hand labor in attaching the metal mesh medium to the core. The plastic used, of course, necessarily must be unaffected by the corrosive qualities of the liquids that it filters and has to withstand temperatures as high as those recommended by the oil manufacturers.

As with all other things in today's highly complex industrial technology, the manufacturing of a filter is no simple process. Before a thought is given to the actual unit many factors must be considered. A few of these are: viscosities, the capacity which the filter must have, operating pressures, maximum pressures, size and type of pipe connections, intermittent or continuous duty, amount and type of solids that must be filtered out, required efficiency of medium with regard to particle size, and such considerations as the use of special metals when corrosive liquids and gases are being handled.

Filter media are a case in point. From the first shred of cloth that went into the initial Dollinger filter, the company has moved to offering about 100 standard media. These vary from several Feltex grades (felt is still regarded as a highly efficient, low-flow-resistant, and reasonably priced medium) to such exotic fibers as those made of thermoplastic resins, woven glass, and high-efficiency multilayered paper.

Because of these variables, Dollinger has a staff of ten engineers that handle inquiries needing special attention. The backlog of experience and know-how that Dollinger has built up over the years means that rarely does a filter need a completely new design. Normally an existing one can be redesigned to fit the needs of the unit in question. One special problem, however, is increasingly time consuming. The manufacturer must be sure that all its units meet the various society and state vessel codes in effect where the filter will be used. One engineer is employed full time to meet this responsibility.

Backing up the engineering staff is a research group consisting of a director

and two assistants. At their disposal, among other equipment, are three wind tunnels. Two of these duplicate Bureau of Standards chambers used for filter testing. A third, larger capacity tunnel helps in design by allowing study of air-flow. The research department also has a chemistry lab and other testing apparatus.

In the Dollinger line today, air-intake filters continue to make up an important part of the business. Most applications now are in the industrial line instead of the original automotive use. The standard Model D intake filter is still basically a metal housing with a radial fin insert having a felted filtering medium. The cloth is mounted on a metal mesh form. Air enters the bottom of the cylinder, passes through the cleaning element and is drawn down through the core to the engine or compressor. The inserts can be vacuum cleaned many times and are replaced when worn out. Thirty-nine standard D sizes are built for handling capacities from 60 to 10,000 cfm; most of these are also available with a modification for silencing. Other intake units are Model G, a low-cost unit of high efficiency for sites where dust is not excessive; Model IDR, a totally enclosed unit that is designed to be installed at ground level to take advantage of the cooler air and lower dust concentration there; Model C, an inexpensive unit similar to the original air-intake filters; Model BR, for crankcase and storage tank applications, having an all-metallic insert; and Model KE, a simplified version in which an inexpensive cloth medium is slipped over the metal-mesh inner form.

The Staynew line of pipeline filters cleans air for special applications as air tools and pneumatic controls, and also filters natural and manufactured gases and corrosive gases. This type has a 2-way action and consists of two main parts: a closed outer housing and a filtering insert inside. They are separated by an internal air space. The air or gas to be cleaned enters the top of the outer housing. It is deflected against the walls and then downward at high velocity. This mechanical action separates out the heavier particles of rust, scale and dirt. Filtration occurs as the gas, having been mechanically cleaned, rises at low velocity through the filter insert. This removes the light air-borne material and the clean gas passes out the discharge.

The advantage of this type of construction comes from the initial mechanical separation of the heavy particles and, because of the low velocity through the inner member, a low resistance to air flow. These units are made in many models, some of which will handle pressures to 10,000 psig and temperatures to 2000° F.

The largest Dollinger products are gas filters. These were developed shortly after World War II when many utilities across the U. S. began converting from manufactured to natural gas. Manufactured gas is naturally wet and lines that handle it develop a certain amount of internal rust. This is seldom a problem because the moisture keeps the pipes lubricated and the relatively heavy moisture-soaked rust does not move with the gas. Natural gas, however, is dry and when the gas lines started to carry it, they began drying out. The rust scaled off and was swept along with the gas. The tiny particles clogged district regulators. Some even extinguished home pilot lights, vexing housewives used to uninterrupted service. This problem was eventually solved by gas filters like the Dollinger unit using the double action principle. The flow of gas, along with the entrained water, oil and foreign particles, is directed at high velocity into the base of the outer housing. The unwanted heavier material is deposited here while the gas rises, passes through the filtering insert and is discharged at the bottom.

The largest unit Dollinger Corporation has ever built is a 15-foot-high monster gas filter that is shown in an accompanying photograph along with one of its two huge inserts. The standard members of this line handle pipe sizes from 2 to 10 inches and range from 28 to 85 inches in height. The shipping weight of the largest is 4800 pounds.

Staynew liquid filters purify oils, water, chemicals and coolants—in essence, any liquid that has a special job to do. Because of the large variety of substances that must be cleaned, a broad spectrum of filtering media is necessary. These include fabrics of plastics and natural rubbers and metallic meshes. They will filter out particles down to a size smaller than 1 micron. This filter consists also of an outer housing with an insert that does the cleaning. Slip-on media are a feature. The area of the filter cylinder inside is designed to be much greater than the area of the outlet pipe. This means that the liquid passes through the medium at low velocity and resistance is held down. Corrosive liquids, of course, present a special problem so are filtered by units built of stainless steel, Monel and Herculoy.

Other lines of Dollinger units include: sump filters for hydraulic and lubricant oils; specially designed compressed air models; a home filter for cleaning natural gas; and an extensive line of automatic, dry and viscous panel types.

Shortly before the company was formed in 1921, the founding Dollinger raised funds by selling common stock to individuals and built a manufacturing plant. Today the company is housed in two buildings in Rochester, neither being the original structure (it was last used in 1941). In the headquarters building are administrative and executive offices, offices for engineers and the research staff. Elements are manufactured in the building along with the newly introduced line of OEM filters. In another plant, in a different section of town, the heavy manufacturing tasks are done—sheetmetal work, welding, machining, and painting. This also is the warehouse and all filters are shipped from here.

Dollinger Corporation today employs an average of between 150 to 200 persons and epitomizes the smaller but mature U.S. concern. During its 40 years it has grown continuously with industry, using a hard-won reservoir of technical knowledge to produce products for a broad range of customers.

NEW COMPRESSOR **This Ingersoll-Rand Type 30 compressor, Model 15 TE, supplies plant air for use at the Dollinger heavy manufacturing shop. Note the Dollinger air-intake filters, two of which clean air going to a second Type 30. Air is used to power tools, for painting and for cutting metal.**

PERIODIC PREVENTIVE MAINTENANCE

Filters, Regulators, Lubricators, Air Cylinders and In-Line Valves

THREE of the six basic reasons for most premature tool failures have to do with air system accessories. These are, though not in order of prevalence: (1) excess moisture from the air line; (2) rust, scale and dirt particles entrained in incoming air; and (3) lack of lubrication.* The first leads to rapid corrosive wear of parts and sticking of valves. The second forms a notorious abrasive action; the third, undue friction leading to checking and spalling.

It is obvious that any complete program of preventive maintenance should include those devices in the air system that help eliminate these trouble spots.

Filters, Regulators and Lubricators

Filters, regulators and lubricators, whether purchased as combination units or singly, frequently are forgotten as soon as they are installed. Seeing empty lubricators, dirty filters or full filter bowls around a plant indicates that there is not a really complete preventive maintenance program. Money is being needlessly wasted.

Regular routines must be established to drain filter sumps of contaminants. In most cases, this should be daily. Once a month, the filter bowl should be removed and swished in a solvent. Be sure the solvent selected is not harmful to plastic, if that is the type of bowl your company uses. While this is being done the filter cartridge can be removed and cleaned. Usually all that is required is to wash it in solvent and blow it off with compressed air.

Failure to do these three things—drain the sump, flush the bowl, and clean the cartridge—will mean that the filter will be flooded and useless, the cartridge will be so caked with dirt it will choke off the free flow of air decreasing tool output, and the bowl will lose its transparency making impossible visual inspection.

Pressure regulators allow compressed air to do a better job the most economical way. They require little maintenance, but this does not mean that they can be overlooked. Remove the bottom plug once a month and blow off the inside parts. If there is a screen in the plug, clean it too. Remember to replace it. The screen is there for a purpose.

Air line lubricators must have oil to function properly. Regular daily or weekly filling routines are required, depending on the amount of air used. Determine which lubricator in the air system requires filling most often. Time the routine for all lubricators according to the needs of that one.

If a lubricator has no sight glass, the oil level should be periodically marked on the bowl. Check it later to see if oil is actually being used. Your maintenance men should never say they like a certain lubricator because it seldom needs filling.

Lubricator bowls need the same regular cleaning as do filter bowls. Often moisture and dirt settle to the bottom of the bowl, under the oil. Since this is at the entrance of the siphon tube, these contaminants will be picked up first if not removed. They should be drained off through the petcock each time the lubricator is filled.

Often maintenance routines can be lightened if thought is given to the type of air line accessories available before they are purchased and installed. Consider automatic-draining filters. Be sure lubricators are easy to fill.

Valves

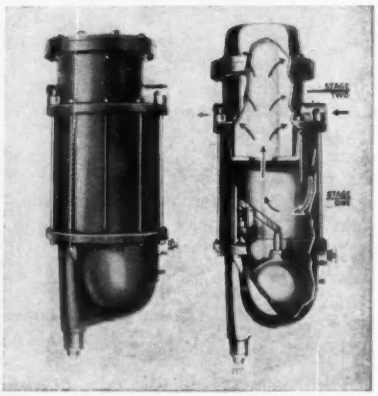
Comparatively speaking, maintenance of valves is easy. But because of this, it should not be overlooked. Valves can leak air to atmosphere. This is costly. They can also leak air downstream putting undue burden on shut-off mechanisms of the pneumatic tools on the line. This is poor practice. These shut-off devices are precision machined parts compared to the closing devices in valves. Constant air pressure on them aggravates tool wear.

Valves are essential to every air system. Because they require a certain amount of periodic maintenance is not an excuse for not using them. In lines where there are insufficient valves, such malpractices follow as noted last month—stuffing hose in dirt and sand to stop air flow, bending hose sharply while changing tools, etc.

Valves should be protected from external damage. Stems should not protrude where they can be hit by moving materials, trucks and the like. One manufacturer has found that putting a curved piece of metal over valves serves not only to protect them, but as a convenient rack for hose that is not being used. Hose should not be hung over exposed valve stems, even though they are handy. It is harmful to both the hose and the valve.

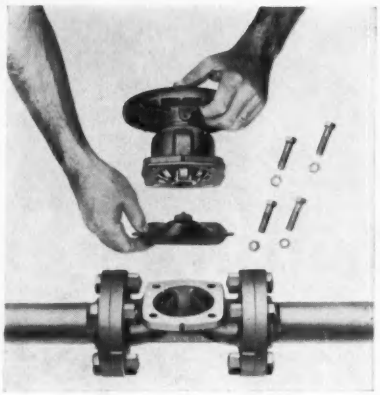
Valves can be generally divided into three broad categories, depending on the method of closing off air flow. First are those that depend on metal pressing on a nonmetallic diaphragm. The second group includes valves such as globe, gate and needle, where the closing action results from a metal-to-metal contact. The third division (which includes plug valves and some ball types) uses a lubricant on the metal-to-metal contact to assure positive sealing.

In the first, maintenance concentrates on the diaphragm. This is the only part of the valve that is normally subject to wear. Depending on the type of service it may last almost indefinitely. Generally the diaphragm can be easily replaced without removing the body of



AUTOMATIC DRAIN The Wilkerson air filter illustrated has a float-operated automatic drain. This is important in shops that mantain many filters, for it requires less periodic maintenance than those that must be drained manually. Note too that it has two stages of air separation and filtration for better cleansing of air.

* The other reasons are improper installation of strainers at inlet ports of pneumatic tools; manual abuse and misuse; and failure to replace worn, inexpensive parts (See Compressed Air Magazine, January 1961, page 11).



LOW-COST Only the diaphragm in this Grinnell valve is normally subject to wear. Depending on the type of service it may last indefinitely. The diaphragm can be replaced without removing the body of the valve from the line, as shown. Note that there are no packing glands or disc holders to demand attention. There are no metal-to-metal seats that have to be refaced or reseated.

the diaphragm valve from the air line.

Those valves with metal-to-metal seating must be checked if leakage is noted to see that seat surfaces are dressed. Some models have renewable seats. These can be changed at a very nominal cost and fresh ones should be kept in stock.

In the third type, lubrication is essential. Normally lubricant lasts a long time. When leakage is noted, the correct quantity of the specified lubricant should be added. Check the condition of the metal-to-metal contact at the same time.

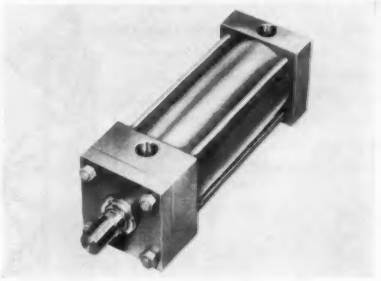
Generally all valves need lubrication of exposed moving parts—stem threads, yoke sleeves, fulcrum pins of lever-operated valves, and points of friction. Packings must be replaced when they show signs of leakage. Seat leakage should be cured by repair as soon as possible.

Air Cylinders

Although neither pneumatic tools (as they have been discussed in this series), nor actually air line accessories, air cylinders deserve thought before leaving the subject. What has been said about clean, dry, well-lubricated air holds true for air cylinders. It is recommended that filters and lubricators be used in line, just as they are with pneumatic tools.

Air cylinders come in an endless variety of sizes and with numerous variations. Consider the heavy-duty general-purpose air cylinder (working pressures to 200 psig). A typical one is illustrated. Such a cylinder must be installed carefully, following the manufacturer's instructions exactly. It should be protected from external damage from, say, paint or weld spatter. These could ruin the rod finish, resulting in excessive wear of the gland seals during operation. During installation, port thread protectors should not be removed until the cylinder is ready to be connected to the shop air line. These protectors keep out dirt, chips and other foreign matter.

At the time of installation, alignment of the piston rod with the machine part must be checked, in both extended and retracted positions. Side load must not be tolerated.



LONG-WEAR This typical, heavy-duty, general-purpose air cylinder (Series A) is manufactured by Hannifin. Little can go wrong with the device if proper steps are followed during installation, gland packing replacement and piston seal servicing. Manufacturer's installation and maintenance instructions should always be followed.

When connecting the air lines to the ports, be sure the lines are free from dirt and water that might severely damage the cylinder. Filters installed in line will continue this protection of the cylinder.

When the cylinder needs servicing and is disassembled, old seals should be removed and all parts thoroughly cleaned. Examine the bore and piston for signs of scoring. Replace if necessary.

Air cylinders have been called the workhorses of industry. Certainly they will perform admirably and have a long service life if these few simple rules are followed.

—S.M.P.

THE PLANT illustrated is a giant all-steel dome-like structure that encloses $2^1/_2$ acres of floor area without internal supports. The diameter is approximately 380 feet; height, 120 feet at center. It can be seen in the northwest part of Wood River, adjacent to East Alton, Ill., a short distance from U. S. Alternate 67 and State Route 159.

The Wood River Dome was designed and built by Graver Tank & Manufacturing Company, East Chicago, Ind., a division of Union Tank Car Companies. Some of the important advantages in industrial design and construction, according to UTC president E. A. Locke, Jr., include economy of cost per square foot, visual control of all working areas from a central point, and unimpeded flow of work and materials.

The dome has the distinction of being the largest structure to be built from the top down. Graver Tank used a huge nylon bag that literally lifted the dome on air. As work progressed, the dome was raised pneumatically, making room for additional rows of panels to be added at ground level. Ultimately, the entire dome shell—more than 500 tons of steel—was supported by an air pressure of only 1.6 ounces per square inch.

Union Tank Car's Wood River Plant will provide regional maintenance for the company's 53,000 railroad tank car fleet. It is the second such structure built for this purpose by UTC, the other being completed in 1958 at Baton Rouge, La. (See *Compressed Air Magazine*, January 1959.)

THINK BIG

Bigger and better than its predecessors, the QM-5 is designed to make Swiss cheese of granite and to drill holes up to 9″ bore size at a rate that will give a production of up to 457 tons per hour with lowest bit cost per unit of production.

New features include angle drilling to 25 degrees, a maintenance-free ejector type dust collector, enclosed operator's cab and full working platforms. Also, choice of famous DHD-500 and DHD-400 Downhole drills for hole sizes from 7½ to 9 inches. Air power is supplied by two Gyro-Flo 900 rotary compressors available in diesel or electric drive.

Ask your Ingersoll-Rand sales engineer for the full Quarrymaster story.

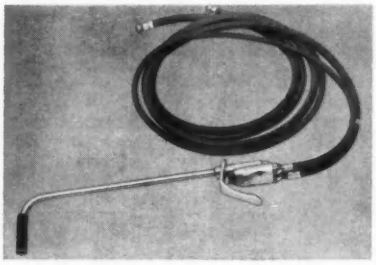
Ingersoll-Rand
QUARRYMASTER

Ingersoll-Rand
228A5 11 Broadway, New York 4, N. Y.

A CONSTANT STANDARD OF QUALITY IN EVERYTHING YOU NEED FOR DRILLING ROCK

Industrial Notes

LARGE VOLUMES of air for cleaning, coupled with precise, metered control of liquid for coatng, make the Calco HBG-18 blow gun ideal for a wide variety of maintenance and production operations. The gun uses a single dual-action control lever. When the lever is depressed to a half-down position, the gun discharges a large volume blast of air through a $^3/_8$-inch opening. When the lever is completely depressed the gun discharges the air blast plus a metered amount of solvent, lubricant, paint or other fluid to coat or clean a workpiece. The gun operates on siphon action with almost any liquid and thus requires no pressure tank. Operating air pressure

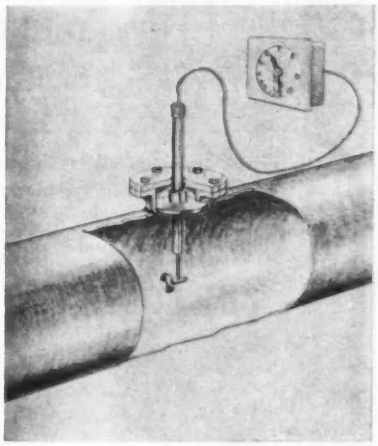


ranges from 40 to 100 psig. The pressure determines the amount of air discharged, but the full $^1/_4$-inch air opening handles much larger volumes of air than can be accommodated by much smaller openings common to other types of blow guns. Rate of liquid discharge is positively controlled by a single screw-type metering adjustment with a 0.02- to 0.11-inch orifice range, according to company reports. Standard extension tube on the gun is 18 inches long with a 90-degree turn at the end. Total weight of the gun and the extension is only 17 ounces. The gun is self-cleaning; no disassembly is required. *Calco*, 2700 E. Main Street, Columbus 9, Ohio.

HIGH-SPEED, lightweight pneumatic grinders, Series 15, reduce production time and minimize operator fatigue. At the same time they provide easy access to all areas of a workpiece in metal grinding or buffing applications. There are twelve new grinders in the series, with free speeds of 6000, 9000, 12,000 and 15,000 rpm. A sensitive weight-type governor gives positive and accurate speed control. The units measure only $16^5/_8$ to 18 inches in length and weigh $6^1/_2$ to $7^1/_4$ pounds. Their excellent power-to-weight and size ratios result from the engineering design of the grinders. The motor is longer, but only slightly larger in diameter than previous units. This keeps the vital side-to-center distance only $1^5/_{16}$ inches. Handles may be of the grip or straight type; throttles may be either thumb or lever. The manufacturer also reports an improved muffler design that lowers operation noise by about 15 decibles from comparable tools. Tool life is lengthened by a built-in motor lubrication system and an integral air strainer that keeps foreign particles out. *Ingersoll-Rand Company*, 11 Broadway, New York 4, N. Y.

CENTRIFUGAL entrainment separators, Type T, have separating and scrubbing action. As the steam, air or gas enters this unit, it rushes through a confined passage at high speed and follows a circular whirling path around the outer wall. Centrifugal action forces the heavier moisture and solids against the wall; they drain to the bottom of the separator and through the outlet to the trap. The vertical escape chamber is large by comparison to the inlet passage and is located in the center of the vessel, high above the bottom drain. The velocity of the air, steam or gas is suddenly reduced when it reaches this chamber. The lowered speed coupled with a high location and the fact that the entrance to the escape chamber has no contact with the outer wall, is said to virtually eliminate re-entrainment problems. For further details, Bulletin 810-A has been made available to compressed air and gas users. *Wright-Austin Company*, 3245 Wight Street, Detroit 7, Mich.

MARK V comes from Ramapo Instrument Company. It is an improved flow transducer for accurate and economical measurement of fluid flows in large pipelines. It can be provided for pressures to 5000 psig and temperatures to 600° F. It is maintenance-free, no special bleed lines or plumbing being required. Furthermore it is said to be contamination-free and has no moving parts. The instrument, in the form of a probe, is applicable to unlimited line sizes and flow rates. Installation is inexpensive, opera-

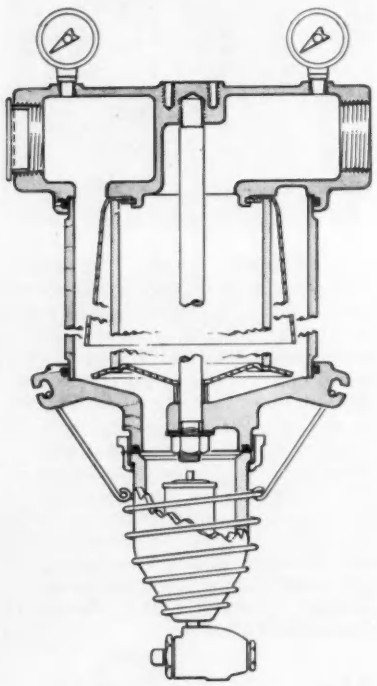


tion is reliable, and pressure loss is low. Unlike orifice, venturi, or turbine-type meters, the relative cost of the Mark V is reduced as the line size increases. The unit meters any fluid—including oils, fuels, hydraulic and abrasive fluids, and most slurries, acids and caustics—any fluid that can be safely contained in stainless steel. The transducer can be remotely located and the signal telemetered many miles. Systems can be provided to permit indicating, recording, controlling and totalizing flows. *Ramapo Instrument Company, Inc.*, 8 First Street. Bloomingdale, N. J.

THE TECMA air filter illustrated is for 2-inch air lines. Its design is such that operators can readily see when the filter needs cleaning. Pressure drop is indicated on the two gauges (top); sediment

or excess water can be seen in the transparent plastic bowl. To clean the ele-

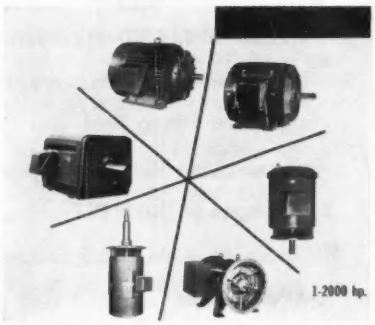
ment, only one hand ring and a single nut must be removed. In case sediment clogs the automatic dumping device, pressing a button will cause the filter to



be cleaned by full line pressure. Then the trap mechanism returns to full-automatic operation. Moisture removal is said to be complete, for it is accomplished by centrifugal action, element protection and quiet-zone baffling for water accumulation. Pressure drop is

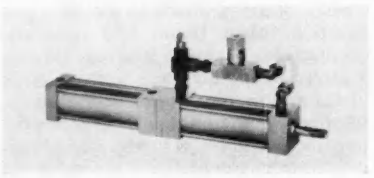
low at full line capacity (1 psig, passing 600 cfm). Working pressure is 125 psig. Although available for 2-inch pipe, adapters are obtainable that will make the filter useful on 3-inch lines. *Techmatic Specialties Inc.*, Royal Oak, Mich.

FULL-COLOR Bulletin B-2515 shows and describes the complete line of Reliance Duty Master a-c motors from 1 to 2000 hp. Product features of each are clearly outlined and explained to make easy the selection of the right motor for every application. Accompanying the



pictures and descriptions is a detailed outline of the production facilities and procedures that are used to manufacture Duty Master motors. Copies of the 16-page brochure are available without charge. *Reliance Electric & Engineering Company*, 24701 Euclid Avenue, Cleveland 17, Ohio.

TOM THUMB air-oil tandem cylinders are available in $^3/_4$-, 1-, and $1^1/_8$-inch bore sizes and eight mounting styles. Maximum pressure is 200 psig. The cylinders are designed to fill the requirements of accurate speed control available when using hydraulic cylinders, while at the same time having the advantages of being air operated. Features claimed include noncorrosive barrel, stainless steel piston rod with lip-type rod seals, Delrin rod bushings, Teflon rod wiper



and choice of 0-ring or lip-type piston seal. *Pneumatic-Hydraulic Development Company*, Tom Thumb Division, 317 W. Masterson, Fort Wayne, Ind.

Books . . .

Gases at High Densities and Temperatures (published by Pergamon Press, 122 E. Fifty-Fifth Street, New York 22, N. Y.; P. O. Box 47715, Los Angeles, Calif.; Headington Hill Hall, Oxford, England; 4 & 5 Fitzroy Square, London W. 1, England; 24, Rue des Ecoles, Paris V, France; and Kaiserstrasse 75, Frankfurt-am-Main, Germany) by Yu. N. Ryabinin describes a device in which gases were compressed by the "firing" of a piston in a closed cylindrical volume. The process of compression was isenthropic, with a large increase of pressure and temperature. (Maximum pressure and temperature obtained during compression reached 10,000 kg/cm^2 and 1500-9000° K, respectively, depending on the composition of the gas.) Thermodynamic characteristics, radiation spectra and electrical conductivity of the compressed gases were studied. The book, translated by H. K. Zienkiewicz from *Gazy pri bol'shikh plotnostyakh i vysokikh temperaturakh*, is aimed at physicists and engineers investigating properties of gases at high pressures and temperatures, but will be equally of interest to chemists. The techniques described can be used to study kinetics of chemical reactions in gas mixtures at high temperatures. The book is another contribution in the Pergamon tradition of publishing translations from the Russian quickly and at the least possible expense. Since the cost in time and publishing effort, as well as actual money, of translating scientific and technical works from the Russian is considerable, the Press has reproduced the manuscript by non-letterpress setting and photolithography. By no means does this limit the usefulness of this book. 60 pages. Cost, $4.50.

Compressed Air and Gas Handbook (published by Compressed Air & Gas Institute, 55 Public Square, Cleveland 13, Ohio) is undoubtedly the best single source of air and gas information for all whose profession involves any phase of compressed air or gas. The third edition is expanded and completely revised. A glance at the chapter headings gives an idea of the scope:

Chapter 1: Compressed Air and Gas in Power and Process Service

Chapter 2: Positive Displacement Compressors

Chapter 3: Dynamic Compressors

Chapter 4: The Compressed Air System

Chapter 5: Pneumatic Tools

Chapter 6: Air-Operated Rock Drills and Associated Equipment

Chapter 7: Miscellaneous Air-Powered Equipment and Devices

Chapter 8: General Reference Data

Appendix: Standard for Portable Tool Noise Measurements. Data are presented in curves or tables wherever possible, facilitating their use. Whether the subject is large-capacity centrifugal compressors for use in the chemical industry or multiple pneumatic tools, automatic feeds and air gauging for modern manufacturing, there is an up-to-date discussion in the book. Managers will find the sections on air economy and centralized versus multiple-unit compressed air systems especially useful. Operators will want to refer to articles on maintenance schedules, lubrication, starting up new

compressors, and many others. Even engineering students will have many occasions to refer to the handbook in courses such as machine design, construction, plant layout and industrial engineering. A young graduate starting a career in industry will find the work useful as a source of ideas and as an aid in orienting himself quickly to industrial practices, for there is hardly an industry that does not depend on extensive use of compressed air or gas. Data in every section are presented in the simplest way consistent with the nature of the material. The text has been carefully indexed and cross-referenced to assure its utmost usability. The *Compressed Air and Gas Handbook* is available through local bookstores, or an order may be placed through Compressed Air Magazine's Book and Periodical Department. 592 pages. Cost, $8.

A Hole In The Bottom Of The Sea by Willard Bascom (published by Doubleday & Company, Inc., Garden City, N. Y.). The author, who is director of Project Mohole, has this to say among other things in the introduction: "Man is a curious animal who rides a spinning sphere on its endless track about the sun. For thousands of years he directed his questions outward into a vastness of space spangled with fixed stars and crossed by wandering planets. For not much more than a hundred has he had the means to look inward at his own vehicle."

Project Mohole, if all goes well, will take a long hard look. Its objective is to drill through the earth's crust, pass the mysterious and transitory zone called the Mohorovicic discontinuity, and penetrate the denser mantle that makes up some 80 percent of the earth. Because the crust is shallower below the sea than on land, drilling will be done from a ship. The first step toward this goal is complete. Test drilling for the deep hole was carried out this March and April from an oil-well offshore rig, *Cuss I*, near Guadalupe Island off the western coast of Mexico. In the early tests three holes were put down and the deepest went more than 600 feet into the ocean floor; the rig worked in 12,250 feet of water.

So this book, of course, is not the full story of the Mohole project. That will have to be written sometime in the next few years. The book is this: if you had been invited to be aboard *Cuss I* in the recent tests, the volume would have given you a 1-package source of background. You could have put down the book and stepped aboard with a reasonable idea of what was going on and why.

Bascom first tells a little about how the idea for Project Mohole became a reality (a group of geophysicists were tired of small specialized research proj-

ects and wanted a major one), and of other, earlier ideas for drilling deep into the earth.

Because the story of the Mohole can't be told correctly unless the reader knows something about several fields of science and technology, Bascom spends the major portion of the book on these, and how they are related to the undertaking. In the introduction he already has said something about the structure of the earth and the theories of how it was born. He next covers the delightful field of science fiction that deals with the earth's interior. We go inside with Jules Verne's Professor Liedenbrock, with Sir Arthur Conan Doyle's Professor Challenger (the crust of the earth was the shell of a great animal), and, yes, even with Tarzan. Next we learn something of Evidence In The Rocks, and about Exploring The Crust With Gravity. Other chapters are: Probing With Earthquakes And Explosions; The Examination Of The Oceans; Magnetism, Heat, and Pressure; and Evidence In The Skies (it is amazing how much we learn about the earth by looking into space).

When the reader has finished this much of the book, he is, like it or not, already an amateur geophysicist and oceanographer. He is ready to read about Project Mohole. The final chapters go into detail of this grand scheme's development. There is some good general material about oil-well drilling and how it relates to boring the big hole, and the selection of sites and objectives is covered.

Because the book was finished before the test drilling began, the chapter on Experimental Holes In Deep Water consists of highly educated speculation. From what press reports said about the tests, they went about as expected. Problems arose that had to be solved and there was a good deal of "sweating out," but the major objective of proving the feasibility of drilling the Mohole was attained. (The area near Guadalupe Island, however, may not be a good site for it: high heat readings tend to indicate the area has more volcanic activity than a "typical" site should have.)

A Hole In The Bottom Of The Sea is, above all, a highly readable book, and it is refreshing to have such writing produced by a person who is mainly a scientist and not an author. Along with the technical fare, there are personal anecdotes and humorous incidents that add a great deal. One criticism which might be lodged is that, by holding off for a few months, the chronicle of early tests and what was learned in them could have been included. Possibly this story will go into a second volume along with that of the actual Mohole drilling. 352 pages. Cost, $4.95. —*G.R.S.*

Give your toughest wire rope jobs to **Purple Plus**

Brute Strength

For any job requiring brute strength, Bethlehem Purple Plus, with IWRC, is the rope to use. This top-flight rope is specially engineered, and is rated 15 pct above the catalog strength of Bethlehem Purple Strand—a fine rope in its own right.

Abrasion Resistance

Ability to resist abrasion is where Purple Plus shines. With its tough wires, and the extreme care with which the rope is made, it will give excellent service on jobs where abrasion is a dominant factor.

Durability

Purple Plus reduces wire rope costs because it is built for rugged service. Put it on your roughest jobs and watch it perform.

Purple Plus, with IWRC, is far and away your best buy for the toughest jobs. It's Preformed for easy handling.

BETHLEHEM STEEL COMPANY, Bethlehem, Pa. *Export Sales:* Bethlehem Steel Export Corporation

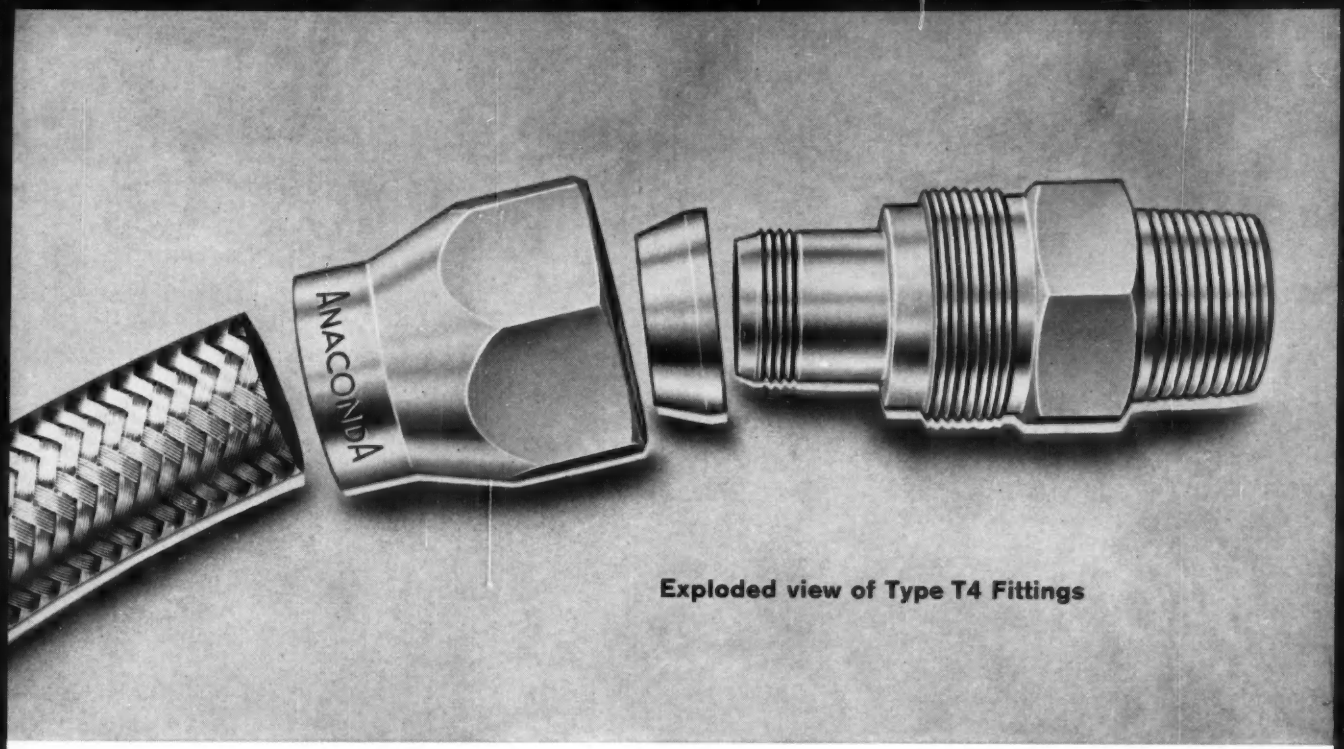
Steel

for strength
. . . economy
. . . versatility

BETHLEHEM STEEL

BETHLEHEM STEEL — BETHLEHEM WIRE ROPE

Index to Advertisers



Exploded view of Type T4 Fittings

Tailor-made Assemblies—

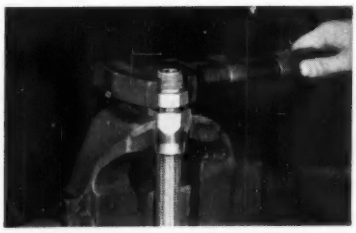
NEW ANACONDA TYPE T4 HOSE OF TEFLON* WITH REUSABLE FITTINGS

Now you can get stainless steel wire-braided hose assemblies of Teflon from your local Anaconda distributor. He can make them up to your exact needs in a matter of minutes, using simple hand tools. It's fast and easy.

Type T4 Hose takes the roughest service. The flexible core is tough virgin Teflon. It's reinforced with stainless steel wire braid for added strength. Reusable fittings for Anaconda Type T4 Hose are designed to withstand high working pressures and temperatures.

Where you can use Anaconda Type T4 Hose. Use it for general industrial uses to handle hydraulic and corrosive fluids, hot tar, steam, air, fuel, food, lubricants and gas – within a temperature range of –65° F through 450° F.

Anaconda Type T4 Hose is available in ⅛-inch through 1¼-inch actual inside diameters. Standard fittings for Type T4 Hose are available in cadmium-plated brass, N. P. T. males. To find out more about how this new assembly can help simplify your maintenance work, fill out the coupon and mail it today. 60126L



It's easy to attach, detach, and reuse Type T4 Fittings. All you need is a vise and a wrench.

*Dupont Trademark

ANACONDA®
METAL HOSE

CA

Anaconda Metal Hose
P. O. Box 791, Waterbury 20, Conn.

Please send me more details about New Anaconda Type T4 Hose and Type T4 Fittings.

NAME.....

COMPANY.....

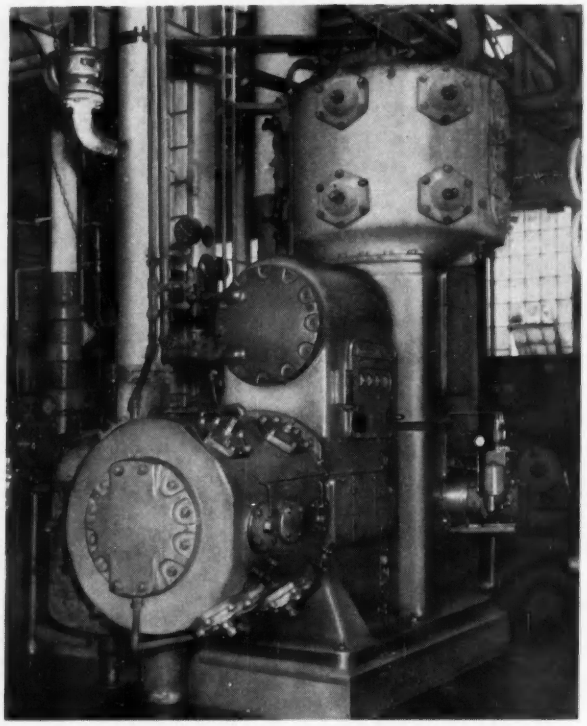
STREET.....

CITY.....ZONE.....STATE.....

IN I-R COMPRESSORS,

TIME TELLS

THE DIFFERENCE



24 hours a day, 7 days a week for five years

43,680 HOURS

with no valve maintenance required!

The 350-hp Ingersoll-Rand **XLE** shown above serves as base load air compressor for the Los Angeles tire plant of The B. F. Goodrich Company. On July 16, 1959, two Channel Valve channels and springs were replaced. This was the first replacement in five years of continuous service – prior to that time, the valves never even had to be cleaned!

At the same time, the old-style intercooler was replaced with the new standard high-efficiency tube-fin type, and the unit went back on continuous service. The unit is still going strong, and no other replacements have ever been made.

This case history is not unusual – it's typical of the performance of Ingersoll-Rand compressors due to a number of Extra-Value features: full-floating aluminum bearings which never need adjustment, filtered pressure lubrication of all parts, sealed frame which keeps out dust and dirt (normally the major cause of wear), and I-R's own air-cushioned Channel Valves which are unmatched for efficiency and long life.

The *extra value* that's built into every type of Ingersoll-Rand compressor pays off with long-run economy. Reduced maintenance and attention, over many years, mean savings in the cost of air power. Ingersoll-Rand offers the most complete line of compressors, in reciprocating, centrifugal, axial-flow, rotary and thermal types. There are units from ½ to 25,000 hp, for pressures from one micron to 125,000 psi. Call your I-R man today for valuable help with your compression requirements.

Ingersoll-Rand

134A1 ♥ 11 Broadway, New York 4, N.Y.

The World's Most Comprehensive Compressor Experience